AD NUMBER
AD271163
LIMITATION CHANGES
TO: **Approved for public release; distribution is unlimited.**
FROM: **Distribution authorized to U.S. Gov't. agencies and their contractors; Specific Authority; 03 MAR 2003. Other requests shall be referred to Army Soldier and Biological Chemical Command, ATTN: AMSSB-ISI-E, Aberdeen Proving Ground, MD 21010-5424. This document contains export-controlled technical data.**
AUTHORITY
ECBC memo dtd 6 Jan 2017

U. S. Army

Chemical Research and Development Laboratories

Technical Report

CRDLR 3122

Variability of Different Intact Human-Skin Sites to the Penetration of VX

by

Van M. Sim

February 1962

ARMY CHEMICAL CENTER, MD.

DEPARTMENT OF THE ARMY
EDGEWOOD ARSENAL
Edgewood Arsenal, Maryland 21010

SMUEA-RM 21 March 1967

SUBJECT: Protective Marking on CRDLR 3122

TO: Distribution List

The protective marking "For Official Use Only" was removed from CRDLR 3122, "Variability of Different Intact Human-Skin Sites to the penetration of VX" by the undersigned on 16 March 1967. Will you please mark your copy and/or copies accordingly.

FOR THE COMMANDER:

VAN M. SIM, M.D.
Chief Scientist
Medical Research Laboratory
Research Laboratories

February 1962 CRDLR 3122

VARIABILITY OF DIFFERENT INTACT HUMAN-SKIN SITES TO THE PENETRATION OF VX

by

Van M. Sim

Directorate of Medical Research

Recommending Approval:

DOUGLAS LINDSEY
Colonel, MC
Director of Medical Research

Approved:

S. D. SILVER
Scientific Director

U. S. ARMY
Chemical Corps Research and Development Command
CHEMICAL RESEARCH AND DEVELOPMENT LABORATORIES
Army Chemical Center, Maryland

[redacted]

FOREWORD

This work was conducted under Task 4C08-02-022-01, Experimental Medicine and Clinical Investigation (U). The work was started in January 1960 and completed in February 1961.

Acknowledgments

To properly acknowledge the technical assistance that was so important to this study would require a lengthy addition to the text. Suffice it to say, many medical officers in the Directorate of Medical Research assisted the author in following the condition of the test subjects. Mr. Carl A. Stearn was largely responsible for providing medical assistants and scheduling subjects; Mrs. Jane L. Stubbs, Mr. William A. Groff, and the laboratory of Mr. Frank Vocci performed the cholinesterase determinations; and Dr. John C. Atkinson prepared the statistical analysis of the data. The assistance of Mrs. Marion P. Royston in preparing this manuscript is also most gratefully acknowledged.

Disposition

When this document has served its purpose, DESTROY it. DO NOT return the document to U. S. Army Chemical Research and Development Laboratories.

DIGEST

Because it was suspected there might be a variability in the sensitivity to penetration of anatomically different skin area, doses of from 5 to 30 μg/kg of VX were applied in a single drop to 19 intact skin sites on humans. Variations in penetration rates were determined from cholinesterase depression and incidence of symptoms.

The following conclusions were reached:

1. Cholinesterase depression by sublethal doses of VX and incidence of symptoms are directly correlated.

2. There is a difference in sensitivity to penetration by VX of various body sites, the head and neck areas being the most sensitive.

3. The more rapid the penetration rate, the more rapid is the onset of toxic signs and symptoms.

4. Oximes appear to be effective in the treatment of VX intoxication.

CONTENTS

VARIABILITY OF DIFFERENT INTACT HUMAN-SKIN SITES TO THE PENETRATION OF VX

I. INTRODUCTION.

Previous clinical studies on the skin penetration of compounds in the V series were relevant to rate of penetration, effect of surface spread, effect of single and multiple drops, and effect of certain additives.[1] In the majority of these studies, agent was applied to the relatively hairless volar surface of the forearm. Because it was suspected there might be a variability in the sensitivity to penetration of anatomically different skin areas, the present study was undertaken. It was believed, if such a variability be evident, these data would be of value in providing guidance for the design of protective equipment, and in arriving at a more valid estimate of the percutaneous LD50 and ED50 for VX in man.

Other questions this study sought to answer are the following:

1. Does the depression of cholinesterase (ChE) levels by sub-lethal doses of VX correspond to the incidence of symptoms of intoxication?

2. Is the speed of penetration related to the speed of onset of toxic signs and symptoms?

3. Is the size of the area covered by VX on the skin a factor in penetration rate?

II. METHODS AND PROCEDURES.

A. Selection and Preparation of Subjects.

Subjects were servicemen (Directorate of Medical Research volunteers) between the ages of 17 and 52 yr, with an average age of 25 yr. Before being considered, each subject was interviewed regarding his medical and family history and given a complete physical examination; blood and urine analyses, electrocardiogram, chest X ray, psychological and psychometric tests, psychiatric interview, and complete medical evaluation.

When on test, all men were hospitalized for 24 hr. All tests were conducted under the ambient temperature and humidity conditions of the ward (approximately 75°F, 60% RH).

Subjects who received the agent on the cheek were clean-shaven unless otherwise stated. Before the agent was applied to any skin area, the skin surface was examined carefully with a hand lens, and any area that appeared to be abraded or irritated was avoided. The skin was not pretreated or decontaminated in any manner during the entire period of the test. After the agent was applied, subjects were cautioned to refrain from touching the contaminated area. They were allowed to move about the ward, but instructed to return to the bed or chair when physiological measurements were scheduled to be made. Food and water intake was not controlled and smoking was allowed.

B. Skin Areas Exposed.

The skin areas exposed and the number of subjects used for each area are graphically indicated in figure 1. Nineteen areas were selected for study.

C. Agent.

The VX used in these tests was from 100-ml samples prepared by the Process Development Division, Directorate of Development, these Laboratories. The compound was stored in individual 5-ml ampules, and a new ampule of agent was used for each day's test. A portion of each test-day's VX was bioassayed (enzymatically and in animals). The biological potency of all material used in these studies was found to be between 90% and 95% of the most active sample previously tested. Repeated chemical analyses indicated that the purity of all VX used was consistently higher than 90%.

D. Dose.

Based on the previous finding that 20 μg/kg of VX (applied as a single drop to the volar surface of the forearm) produced an RBC-ChE drop from 60% to 65% of normal,[1] a standard dose of 20 μg/kg was initially selected for most of these experiments. Doses of 25 and 30 μg/kg were applied to two groups, comprising a total of 12 subjects, in a comparison of the effects of single and multiple drops. During the course of the study, it became apparent that the higher doses were safe for only certain areas of the body, and it was necessary to decrease the amounts applied to the more sensitive areas.

In most cases, the agent was applied as a single drop with an Agla micrometer syringe and in some tests the material was applied as 5 discrete drops arranged to preclude their eventual coalescence.

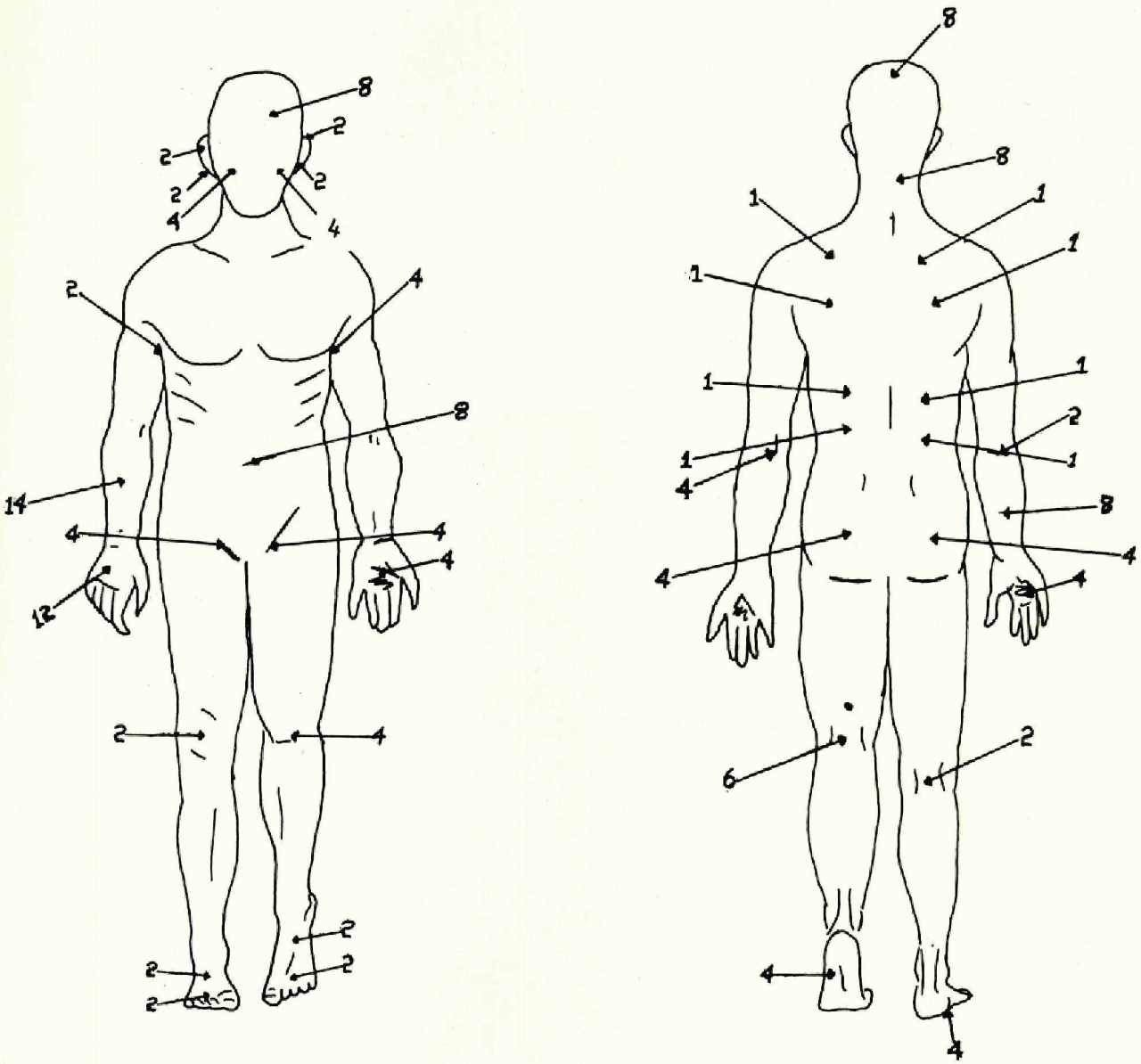


FIGURE 1

SKIN AREAS TESTED

Numerals refer to number of subjects tested on each area.

E. Spread Measurements.

On the morning of each test, 1% Hiltamine (a fluorescent material) was added to the VX solution, thereby permitting a visual measurement of the area covered by the agent when viewed with an ultraviolet-light source. Measurements of spread were made at 1, 10, 30, 60, 180, and 360 min after application.

F. Cholinesterase Determinations.

In most cases, clinical laboratory determinations of RBC-, whole-blood-, and plasma-ChE were carried out simultaneously in three separate laboratories on aliquot portions of the same venous blood sample. On each subject, two control RBC-, whole-blood-, and plasma-ChE values were obtained, one during the man's initial medical screening and one on the day of the test. RBC- and plasma-ChE levels were determined by the modified ΔpH method of Michel, as reported by Stubbs and Fales.[2] Whole-blood-ChE levels were measured by the constant pH-electrolytic method.[3] In some instances, RBC-, plasma-, and whole-blood-ChE values were also determined by a modification of the Hestrin[4] method.*

After the agent was applied, venous blood samples were drawn every 2 hr for 12 hr and again at 24 hr. This schedule was rigidly maintained, sampling time rarely being more than 1 min off schedule. The 24-hr samples were taken on the morning following exposure. In some instances, blood samples were taken more frequently during the first 12-hr period after exposure. Also, intermittent samples were drawn from several subjects for as long as 9 days.

G. Physiological Measurements.

The physiological measurements taken before and during each test (24-hr period) included pulse and respiratory rates and blood pressure; heart sounds and bowel activity were determined by chest and abdominal auscultation. Observers were also alert for local signs, as well as those of peripheral and central-nervous-system origin.

---

* The results obtained from the modified Hestrin method are used in this report only when data are not available for the ΔpH and the constant pH-electrolytic methods. A description of the modified Hestrin method will be included in a subsequent report.

III. RESULTS.

A. Signs and Symptoms of VX Poisoning.

The signs and symptoms exhibited by subjects after exposure included local sweating, erythema or itching of the contaminated area, weakness, muscular fasciculation, dizziness, headache, abdominal cramps, repeated vomiting, and diarrhea. Two subjects had unilateral miosis (figure 2), one after receiving the agent on the forehead and the other on the cheek. Initially, self-contamination of the eye was suspected, but examination of the eyelid revealed no evident trace of the labeled material. In a subsequent test, one man wore a bandage over the eye on the side of agent application and another man wore a bilateral eye shield. There was no miosis in either case. This suggests the possibility that vapor arising from the VX caused the miosis seen in the first two subjects mentioned.

Other than one instance of orthostatic hypotension in a subject on standing (BP = 100/60-40; PR = 126), no significant alterations in blood pressure, respiratory rate, or heart sounds were observed.

B. Effects on ChE Levels of Percutaneously Applied VX.

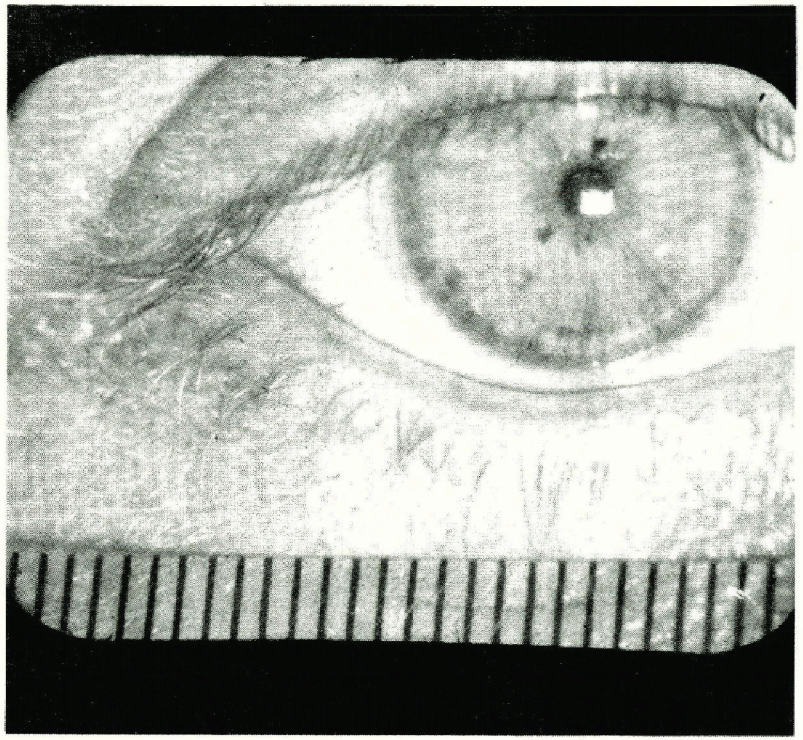
To facilitate comparison, results obtained on the 19 skin areas studied are grouped into three divisions based on functional, anatomical, and histological differences. These divisions are the following:

Extremities (elbow, popliteal space, knee, dorsal and palmar surfaces of the hand, dorsal and volar surfaces of the forearm, and dorsal and plantar surfaces of the feet).

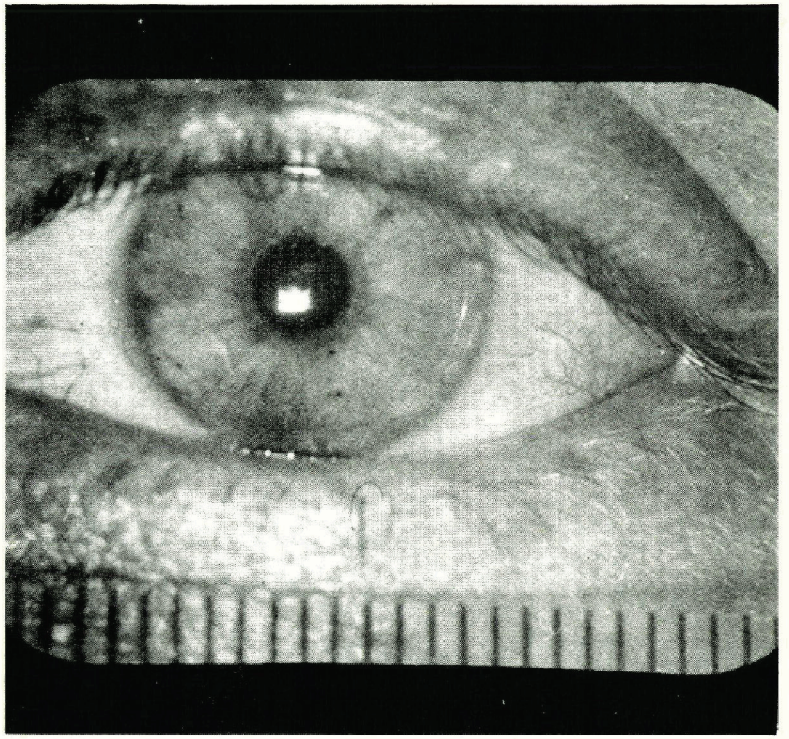
Body [abdomen, groin, buttocks, axilla, and back (scapular and lumbar regions)] .

Head and Neck (ear, cheek, forehead, top of head, and back of neck).

All comparisons of effects are based on the RBC-ChE when these levels are available; when they are not available, whole-blood-ChE values are given. Data on subjects who required oxime treatment are included in the tables and graphs, but it should be borne in mind that the increase in the 24-hr ChE levels of these subjects is attributable largely to the effects of therapy. When the phrase "moderately severe gastrointestinal symptoms" is used to describe a subject's reaction, it refers to nausea, vomiting, and weakness.



LEFT EYE



RIGHT EYE

FIGURE 2

UNILATERAL MIOSIS RESULTING FROM VX VAPOR

Exposure = 5 μg/kg drop on left cheek

The phrase "minor symptoms and signs" refers to headache, nightmares, dizziness, local sweating, and erythema or itching of the contaminated area.

1. Extremities.

Table 1 lists the average figures obtained when VX (20 to 30 μg/kg) was applied to the extremities (see table, appendix, for detailed data). The most sensitive of these areas appears to be the volar surface of the forearm and the popliteal space. Twelve of the 22 subjects who received VX on these extremity areas had drops in RBC-ChE level to 50% of normal or less; five had moderately severe gastrointestinal symptoms, and three required treatment.

There was a slight difference in the results when a 25 μg/kg dose of VX was applied to the dorsum of the forearm in a single drop and when it was applied as 5 discrete droplets. None of the four subjects who had the single-drop dose had a drop in RBC-ChE to 50% of normal, but two of the four subjects who had the 5-droplet dose had a decrease in RBC-ChE to 50% of normal or less. Of the eight volunteers tested on the dorsum of the forearm, one had moderately severe gastrointestinal symptoms and three had minor symptoms and signs.

There was a slight difference in the results when the agent was applied to the dorsum of the hand in 5 droplets (20 μg/kg) and when it was applied as a single drop (30 μg/kg). After single-drop applications, none of the four subjects had RBC-ChE depression of 50% and none showed signs or symptoms, but two of the eight subjects who received the 5-droplet application (at the lower dose) had an RBC-ChE depression of at least 50%, and one of these experienced moderately severe gastrointestinal symptoms.

2. Body.

The second portion of table 1 lists the average figures obtained when VX (10 to 20 μg/kg) was applied to the body areas (see table in appendix for detailed data). All areas tested appeared to be sensitive to agent penetration, with the abdomen being the most sensitive. Of the 38 subjects with neat agent applied to the buttocks, back, groin, axilla, and abdomen, 14 had an RBC-ChE depression of at least 50% within an average of 7.6 hr, 6 experienced moderately severe gastrointestinal symptoms, 9 had minor symptoms and signs, and 3 required treatment. It should be noted that the dose applied to the inguinal area was only half (10 μg/kg) that applied to the other body areas.

TABLE 1

EFFECT ON MAN OF PERCUTANEOUSLY APPLIED VX
(Single Drop of VX Labeled With 1% Hiltamine)

Skin area	Dose	Number of subjects	RBC-ChE (average*)		Plasma-ChE (average*)		Whole-blood-ChE (average*)		RBC-ChE drop to 50% (average*)		Number of subjects with signs and symptoms			Number of subjects treated
			Maximum drop within 12 hr	ChE at 24 hr	Maximum drop within 12 hr	ChE at 24 hr	Maximum drop within 12 hr	ChE at 24 hr	Number of subjects	Time to drop	Moderate	Minor	Total	
	µg/kg		% of normal							hr				
Extremities														
Forearm (volar)	20	14	55 (19-89)	55 (25-92)	76 (46-94)	91 (62-123)	54 (18-100)	60 (24-106)	7	6 (2-10)	4	-	4	2
Forearm (dorsum)	25	4	78 (73-84)	66 (48-80)	71 (60-84)	62 (46-76)	81 (77-85)	73 (58-85)	0	-	-	1	1	0
Forearm (dorsum)	25**	4	49 (23-91)	56 (31-100)	78 (74-87)	89 (72-107)	57 (23-98)	52 (23-98)	2	7 (6-8)	1	2	3	0
Elbow	20	6	46 (27-78)	37 (6-82)	88 (69-97)	88 (69-102)	52 (32-73)	46 (25-71)	3	9 (8-12)	-	1	1	0
Hand (palmar)	20	8	91 (83-98)	110 (96-122)	84 (71-107)	95 (74-113)	91 (81-100)	96 (93-100)	0	-	-	2	2	0
Hand (dorsum)	30	4	94 (81-104)	98 (85-106)	89 (81-96)	107 (98-125)	93 (91-96)	97 (92-102)	0	-	-	-	0	0
Hand (dorsum)	20**	8	56 (18-72)	46 (21-66)	70 (13-88)	99 (60-112)	-	-	2	7 (4-10)	1	-	1	0
Knee	20	6	86 (76-96)	77 (60-93)	89 (72-99)	98 (86-102)	84 (63-100)	83 (64-100)	0	-	-	1	1	0
Popliteal space	20	8	43 (10-83)	49 (32-83)	65 (50-94)	64 (34-94)	39 (9-72)	48 (15-76)	5	7 (4-12)	1	1	2	1
Foot (dorsum)	20	8	84 (71-95)	94 (70-107)	81 (60-100)	99 (72-125)	94 (83-100)	103 (86-125)	0	-	-	-	0	0
Foot (plantar)	20	8	86 (79-94)	86 (75-97)	85 (79-95)	90 (57-118)	90 (65-102)	99 (89-110)	0	-	-	3	3	0
Body														
Buttocks	20	8	71 (24-94)	64 (24-105)	95 (71-116)	98 (65-125)	70 (19-100)	75 (28-100)	1	6	1	2	3	0
Back (dorsal, lumbar, and scapular regions)	20	8	53 (8-91)	55 (30-97)	78 (64-90)	87 (69-109)	58 (7-89)	64 (41-79)	4	8.5 (6-12)	1	4	5	1
Groin	10	8	49 (34-57)	47 (31-72)	70 (58-81)	73 (65-81)	62 (34-87)	55 (15-85)	1	8	-	-	0	0
Axilla	20	6	43 (20-62)	51 (39-67)	76 (59-92)	78 (66-99)	49 (35-85)	55 (30-96)	4	9.5 (4-12)	1	1	2	1
Abdomen	20	8	45 (18-77)	57 (24-94)	74 (50-97)	81 (55-137)	56 (26-91)	61 (34-98)	4	6 (4-8)	3	2	5	1
Head and Neck														
Back of Neck	20	8	35 (22-55)	35 (25-46)	60 (48-69)	61 (48-77)	36 (28-49)	45 (36-54)	7	6 (4-12)	6	-	6	2
Forehead	10	8	32 (20-57)	37 (21-56)	68 (57-79)	72 (57-90)	33 (10-52)	51 (26-82)	7	5 (4-8)	5	2	7	0
Head (top)	5	8	58 (30-90)	51 (24-94)	80 (57-100)	91 (75-113)	62 (31-82)	65 (33-100)	3	7.3 (6-10)	2	1	3	0
Cheek	5	8	29 (5-50)	47 (27-74)	67 (50-79)	69 (47-82)	33 (16-50)	51 (31-93)	8	3.5 (2-6)	4	1	5	1
Ear, lobe, and pinna	5	8	26 (<10-50)	65 (32-95)	80 (61-90)	87 (83-91)	32 (11-52)	48 (32-68)	8	6 (2-12)	5	2	7	2

* Values in parentheses indicate ranges.

** VX administered as 5 discrete droplets.

3. Head and Neck.

The last portion of the table lists the average figures obtained when VX (5 to 20 μg/kg) was applied to the head and neck areas (see table, appendix, for detailed data). Although the doses of VX applied to these areas were, in most cases, considerably smaller than those applied to the extremities and the body, 33 of the 40 subjects (80%) had an RBC-ChE depression to at least 50% within an average of 5.8 hr, 28 (54%) had signs and symptoms, and 8 (20%) required treatment.

C. Effects of Beard Growth on VX Penetration.

There was a very limited study of the effects of beard growth on the penetration of VX. For 6 to 10 days, four subjects allowed the beard to grow; then 5 μg/kg of VX was applied to the cheek. There did appear to be a slight difference between the results obtained in these men (table 2) and those obtained in subjects tested on the cheek who had shaved on the morning of other tests (table 1). In the bearded subjects, maximum depression of whole-blood-ChE was to 15% of normal within 9 hr; in the subjects exposed on the shaved cheek, maximum depression of whole-blood-ChE was to 33.5% of normal in 8.5 hr. Whole-blood-ChE dropped 50% within 2.5 hr in the bearded subjects, and within 5.8 hr in the shaved subjects. The bearded cheek was also more sensitive to penetration than other areas of the head and neck.

D. Relationship Between ChE Depression and Symptomatology.

Table 3 lists data on all subjects who became ill. These data substantiate previous findings[1] that in acute experiments, the drop in RBC-ChE level is directly correlated with symptoms. The median RBC-ChE level at the time of onset of symptoms was 31% of normal. Of the 32 subjects who had a maximum drop in ChE to 30% of normal or less, the 25 (75%) listed in table 3 became ill. The median time to illness was 5 hr when the agent was applied to the head and neck, 7 hr when applied to the extremities, and 10 hr when applied to the body areas. Application of VX to the ear lobe produced illness in the shortest period of time (median is 4 hr) even at the low dose of 5 μg/kg. Although the dose applied to most of the head areas (5 to 10 μg/kg) was only one fifth to one half that of the dose applied to the other areas, the median time to illness when the agent was applied to the ear lobe, forehead, cheek, and top of head was 4.5 hr compared with the median time to illness at the higher doses (20 to 25 μg/kg) on the extremities and body of 8 hr.

TABLE 2

EFFECT OF BEARD GROWTH ON PERCUTANEOUSLY APPLIED VX*

Subject	Weight	Whole-blood-ChE			Signs and symptoms in subjects	Treatment
		Time to 50% drop	Maximum drop within 12 hr**	ChE at 24 hr		
	kg	hr	% of normal			
249-60	87	2	15 (10)	79	Vomited 10 times	1 gm of P_2S in 250 ml of saline was iv injected
250-60	60	4	22 (10)	32	Nausea	None
251-60	92	2	11 (8)	23	Vomited four times; weak	None
252-60	75	2	13 (8)	15	None	None
Average	78.5	2.5	15 (9)	37		

* A single drop of 5 μg/kg, labeled with 1% Hiltamine, was applied to the cheek after a 6- to 10-day beard growth.

** Figures in parentheses indicate hours to maximum drop in ChE.

TABLE 3

RELATIONSHIP BETWEEN CHOLINESTERASE LEVEL AND MODERATELY SEVERE GASTROINTESTINAL SYMPTOMS a/ AFTER SINGLE-DROP PERCUTANEOUS APPLICATIONS OF VX

Subject	Skin area	Dose	Maximum RBC-ChE drop b/	Time to onset of illness after exposure	ChE level at time of onset of illness
		µg/kg	% of normal	hr	% of normal
	Extremities				
235-60	Popliteal space	20	10 (4)	6	31
213-60	Axilla	20	20 (6)	6	20
97-60	Forearm (dorsum)	25	24 (10)	8	31
79-60	Forearm (volar)	20	19 (10)	6	31
81-60			22 (2)	3	22
83-60			28 (8)	21	28
2-60			38 (12)	14	38
32-60	Hand (dorsum)	20 c/	18 (11)	8	36
				Median 7	Median 31
	Body				
162-60	Buttocks	20	24 (10)	10	24
154-60	Back	20	8 (10)	8	33
204-60	Abdomen	20	24 (24)	24	24
196-60			27 (12)	14	27
192-60			38 (8)	6	51
				Median 10	Median 27
	Head and neck				
4-61	Ear lobe	5	11 (5) d/	4	32
7-61			21 (4)	4	21
26-61			27 (6)	3	51
22-61			<10 (4)	3	<10
23-61			<10 (10)	10	<10
143-60	Back of neck	20	34 (12)	8	38
142-60			22 (12)	8	30
141-60			37 (8)	8	37
147-60			31 (4)	5	31
140-60			24 (10)	10	24
145-60			31 (12)	7	33
207-60	Forehead	10	23 (8)	5	24
203-60			35 (12)	7	44
198-60			30 (4)	10	35
195-60			20 (12)	4	34
199-60			33 (4)	9	68
223-60	Cheek	5	31 (4)	5	31
222-60			26 (8)	4	34
238-60			23 (10)	8	33
233-60			5 (4)	4	5
28-61	Top of head	5	30 (12) d/	4	66
21-61			37 (12) d/	5	42
				Median 5	Median 33
		Over-all average	24 (9)	8	32
		Over-all median	24 (7)	7	31

a/ Nausea and vomiting

b/ Values in parentheses indicate hours to reach maximum drop in ChE

c/ VX applied as 5 discrete droplets

d/ Whole-blood-ChE

E. Reactivation of RBC-ChE After Inhibition by Percutaneously Applied VX.

Figures 3, 4, and 5 indicate the spontaneous return of RBC-ChE in six untreated subjects. All but two subjects (195-60, 207-60) reached maximal depression within 6 hr; three appeared to have a rebound and then dropped toward the original low level. Regeneration of RBC-ChE was most rapid within the first 4 days and then ChE activity tended to recover more slowly. This spontaneous recovery of ChE activity inhibited by VX is much more pronounced than that seen after inhibition of ChE by most of the G agents.[5]

F. Effect of Intravenously Administered Oxime.

Figures 6 through 12 indicate the effect of intravenously administered oxime on whole-blood- or RBC-ChE. All subjects were exhibiting signs and symptoms, and all had ChE levels of 31% of normal or below when PAM-Cl (0.5 to 5.0 gm) or P_2S (1 gm) was infused in 150 to 250 ml of normal saline over a period of 10 to 20 min. Weakness, fasciculations, slurring of speech, diplopia, and nausea usually subsided within 30 to 60 min after oxime and did not return.

Previous studies of intravenous VX[6] have shown that 1.7 to 2 μg/kg of VX in the blood stream is necessary to effect the level of ChE depression seen in these subjects. Although no attempt was made to quantitate the effective dose of oxime, it would appear that the lowest dose of PAM-Cl (0.5 gm) would be sufficient to counteract 1.7 to 2.0 μg/kg in the blood stream; however, if the agent were still being absorbed when oxime infusion was completed, subsequent drops in ChE level might be expected. This may be an explanation for the drops in the curves depicted in figures 6 through 12.

G. Relationship of Spread to Penetration Rate.

Previous work[1] suggested that the degree of spreading of the agent droplet is related to incidence of intoxication, the smaller the amount of spreading the greater the possibility of illness, or the greater the penetration rate. The spread readings used in that study, however, were those made at 1 and 3 hr after application, and it was believed that earlier readings might be more valid in calculating penetration rates. The current study, therefore, included spread measurements at 1, 10, 30, 60, 180, and 360 min after agent application, and a statistical analysis was undertaken to determine the regression coefficients of drop in ChE per minute versus calculated penetration rate at the 10-, 60-, 180-, and 360- min intervals.

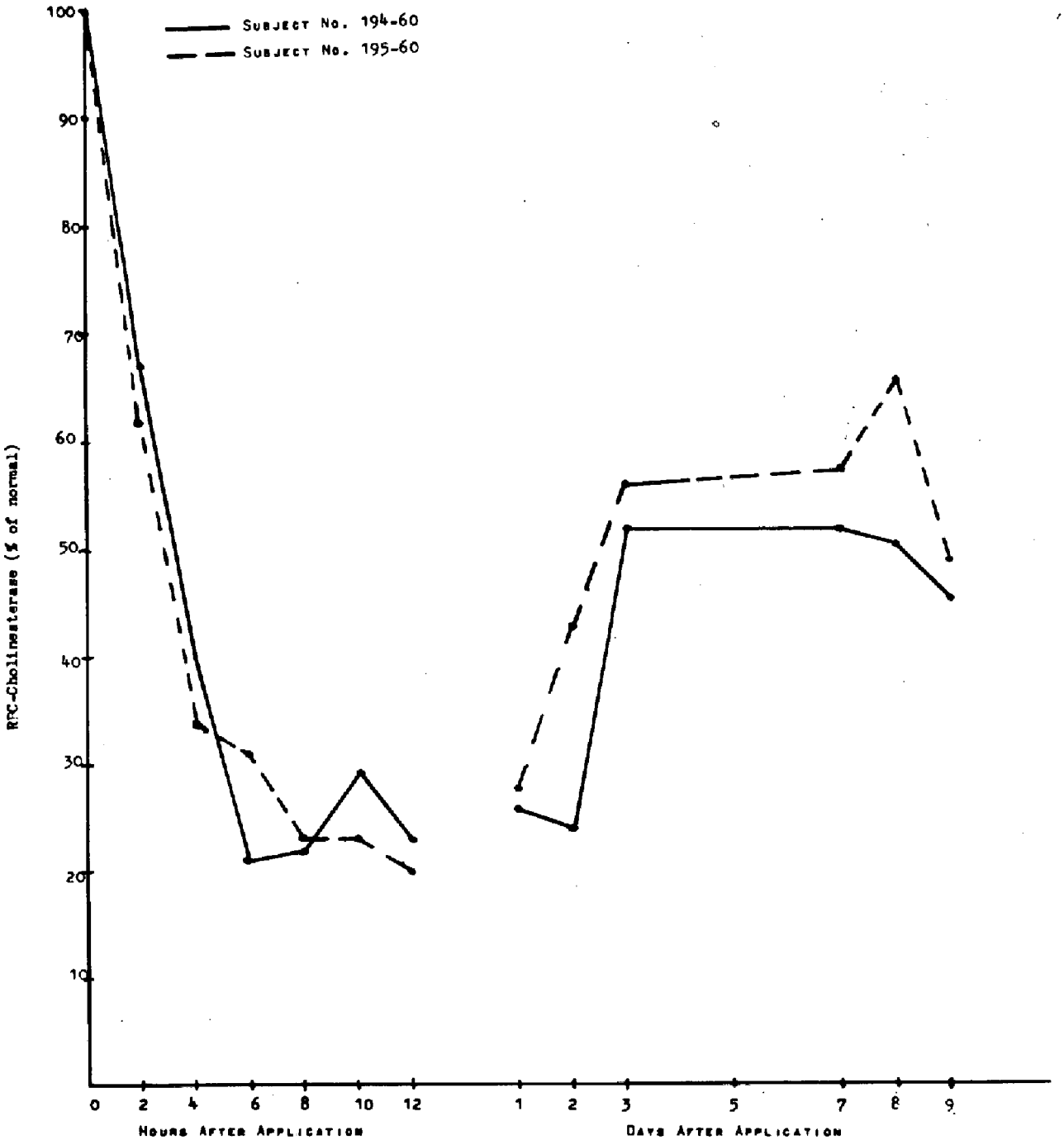


FIGURE 3.

EFFECT OF VX ON CHOLINESTERASE

Dose of 10 μg/kg applied to forehead

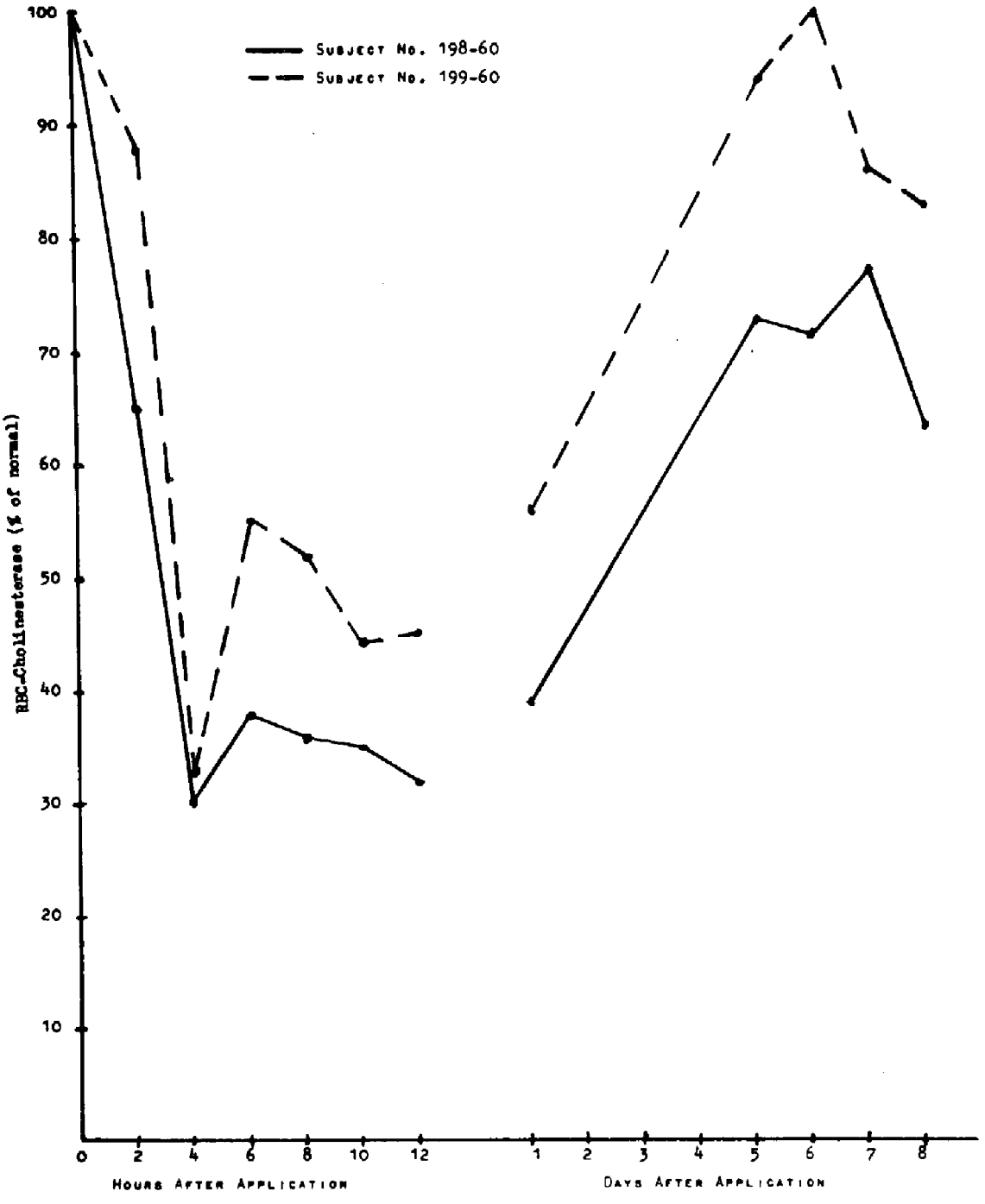


FIGURE 4

EFFECT OF VX ON CHOLINESTERASE

Dose of 10 μg/kg applied to forehead

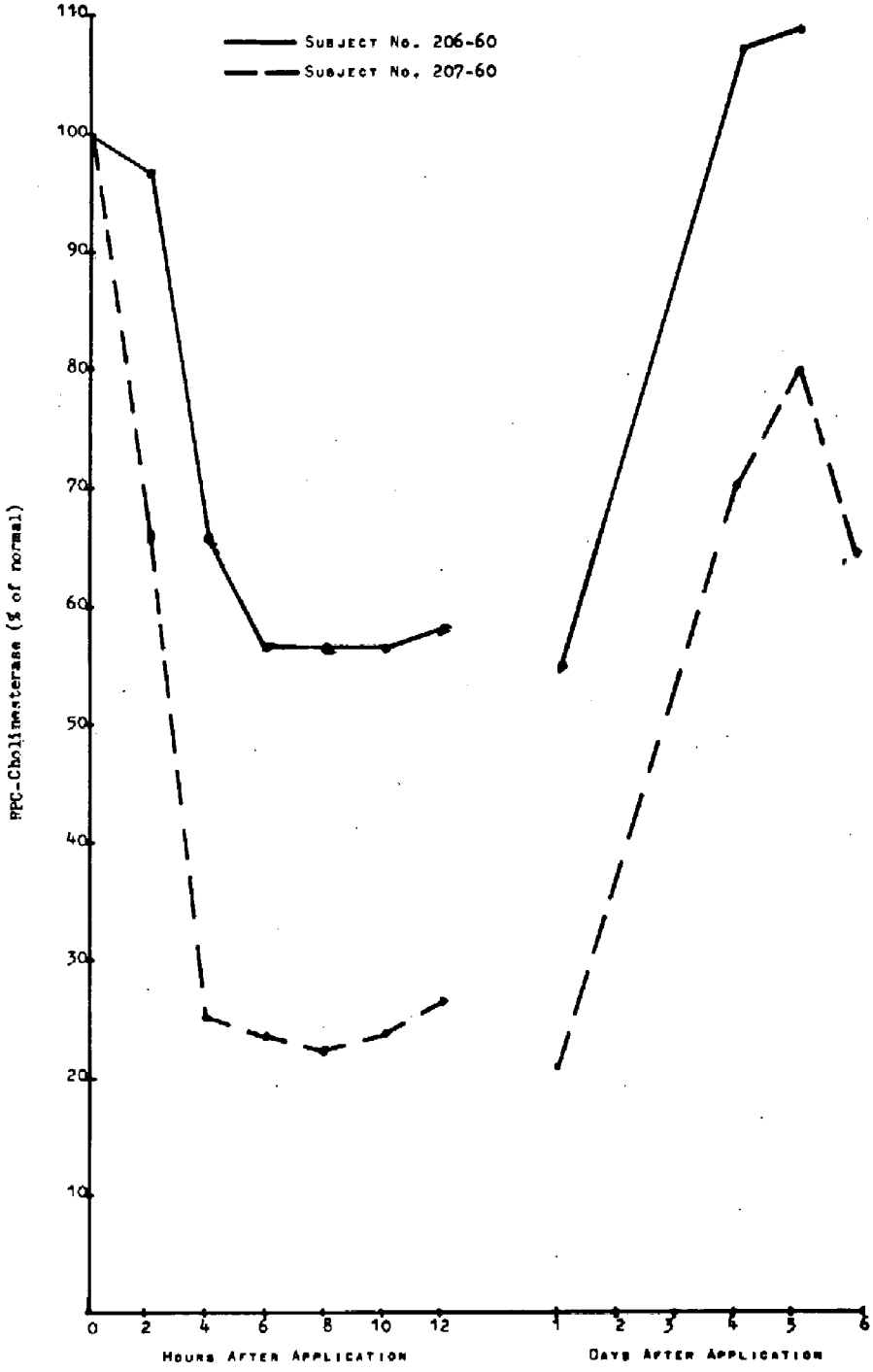


FIGURE 5

EFFECT OF VX ON CHOLINESTERASE

Dose of 10 μg/kg applied to forehead

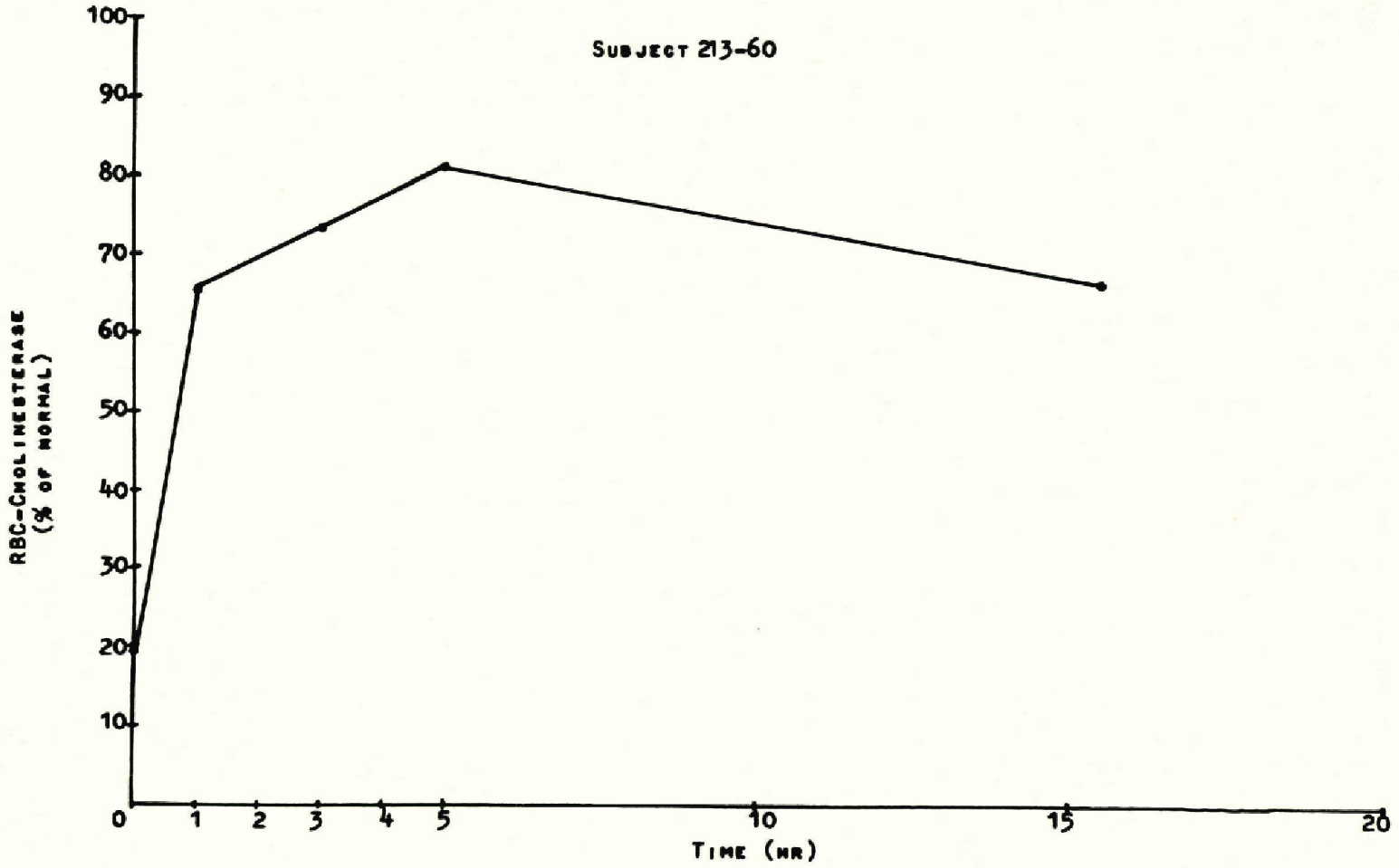


FIGURE 6

EFFECT OF OXIME ON CHOLINESTERASE DEPRESSED BY PERCUTANEOUSLY APPLIED VX

0.6 GM PAM-CL ADMINISTERED INTRAVENOUSLY AT 0 TIME AND 1 GM PAM-CL ADMINISTERED INTRAVENOUSLY AT 0 PLUS 2 HR 40 MIN. 0 TIME = 7 HR AFTER APPLICATION OF 20 µG/KG TO AXILLA.

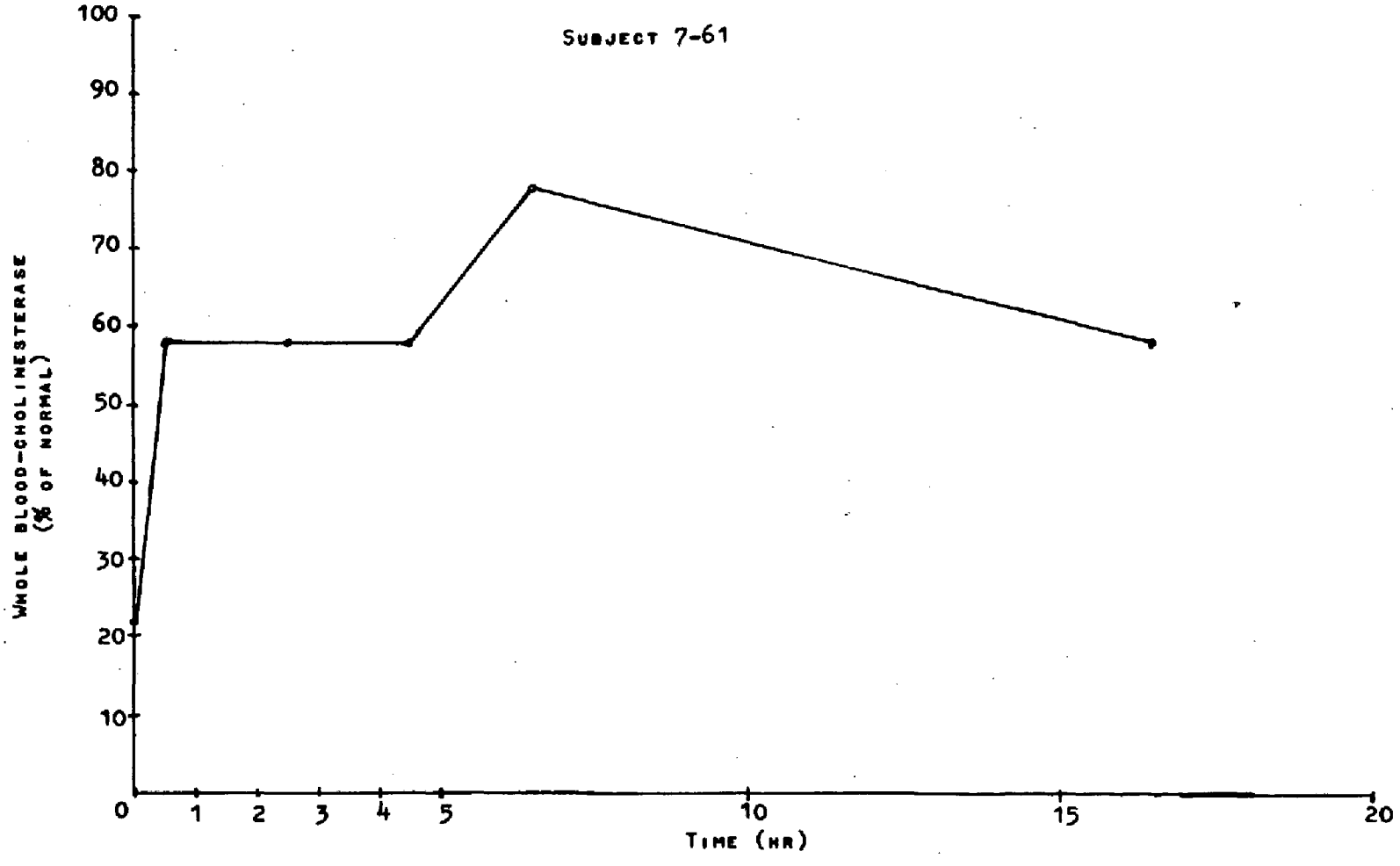


FIGURE 7

EFFECT OF OXIME ON CHOLINESTERASE DEPRESSED BY PERCUTANEOUSLY APPLIED VX

1 GM P_2S ADMINISTERED INTRAVENOUSLY AT 0 TIME.
0 TIME = 5 HR AFTER APPLICATION OF 5 µG/KG TO EAR LOBE.

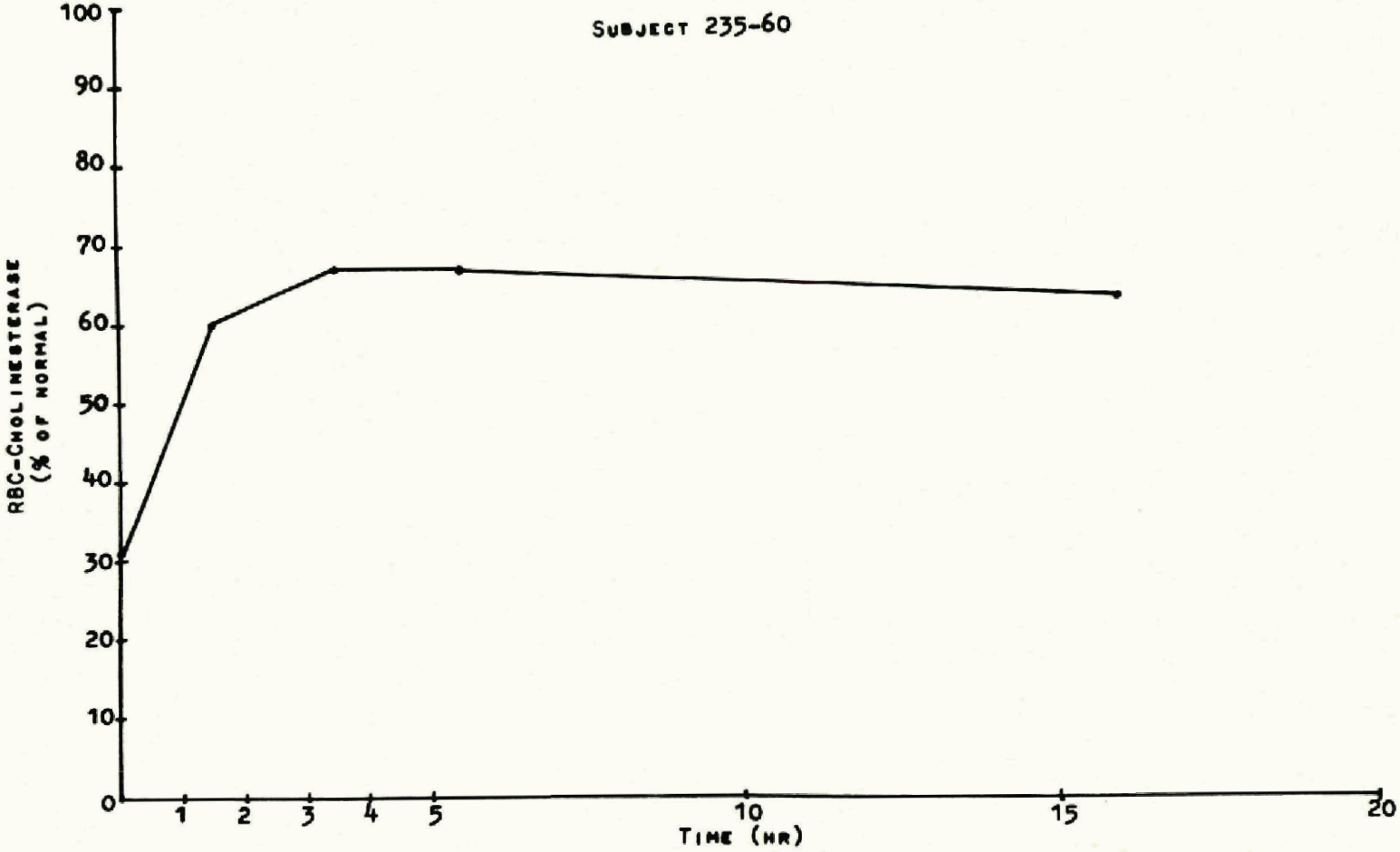


FIGURE 8

EFFECT OF OXIME ON CHOLINESTERASE DEPRESSED BY PERCUTANEOUSLY APPLIED VX

0.5 GM PAM-CL ADMINISTERED INTRAVENOUSLY AT 0 TIME.
0 TIME = 6 HR AFTER APPLICATION OF 20 µG/KG TO POPLITEAL SPACE.

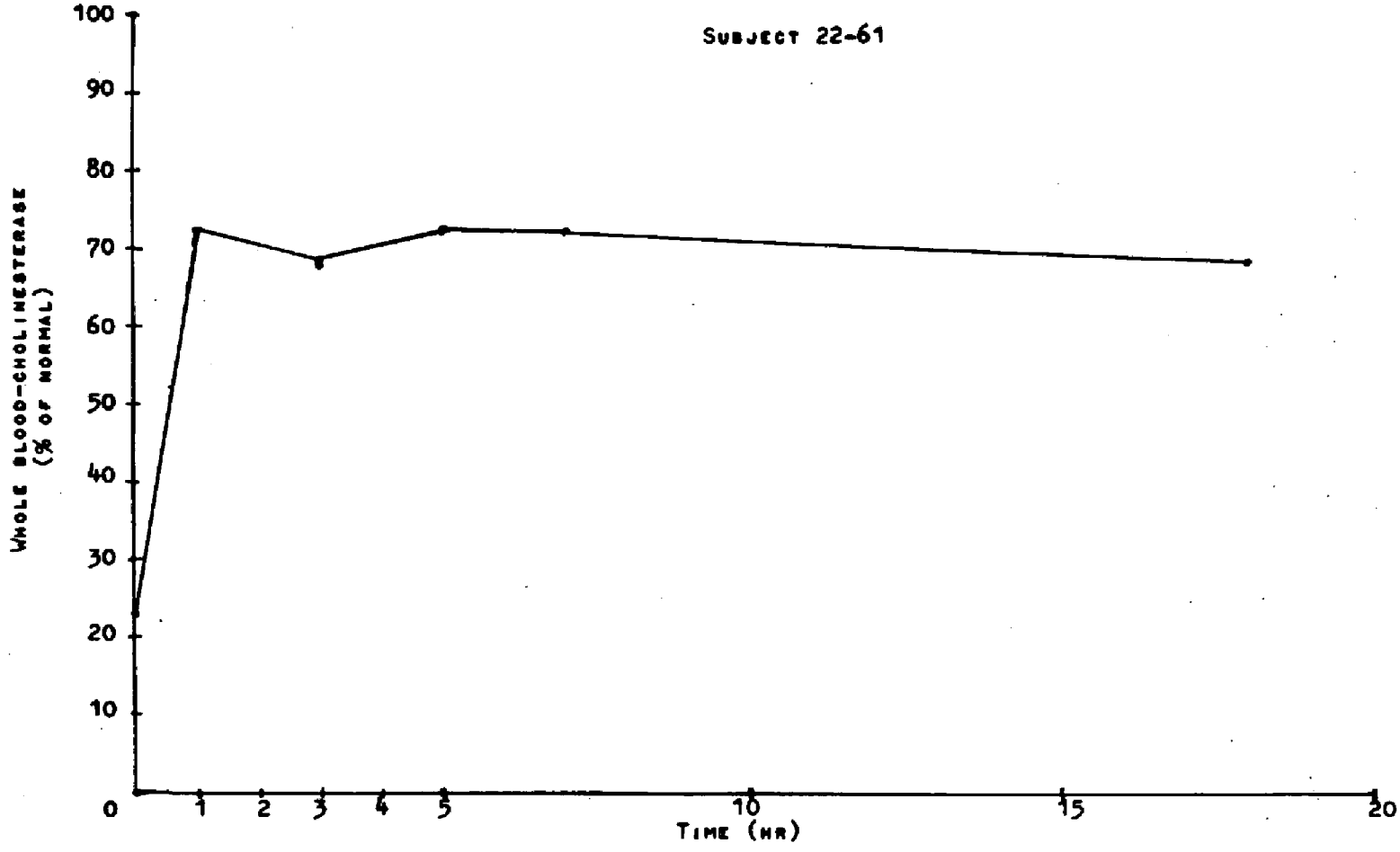


FIGURE 9

EFFECT OF OXIME ON CHOLINESTERASE DEPRESSED BY PERCUTANEOUSLY APPLIED VX

1 gm P_2S administered intravenously at 0 time.
0 time = 5 hr after application of 5 µg/kg to ear.

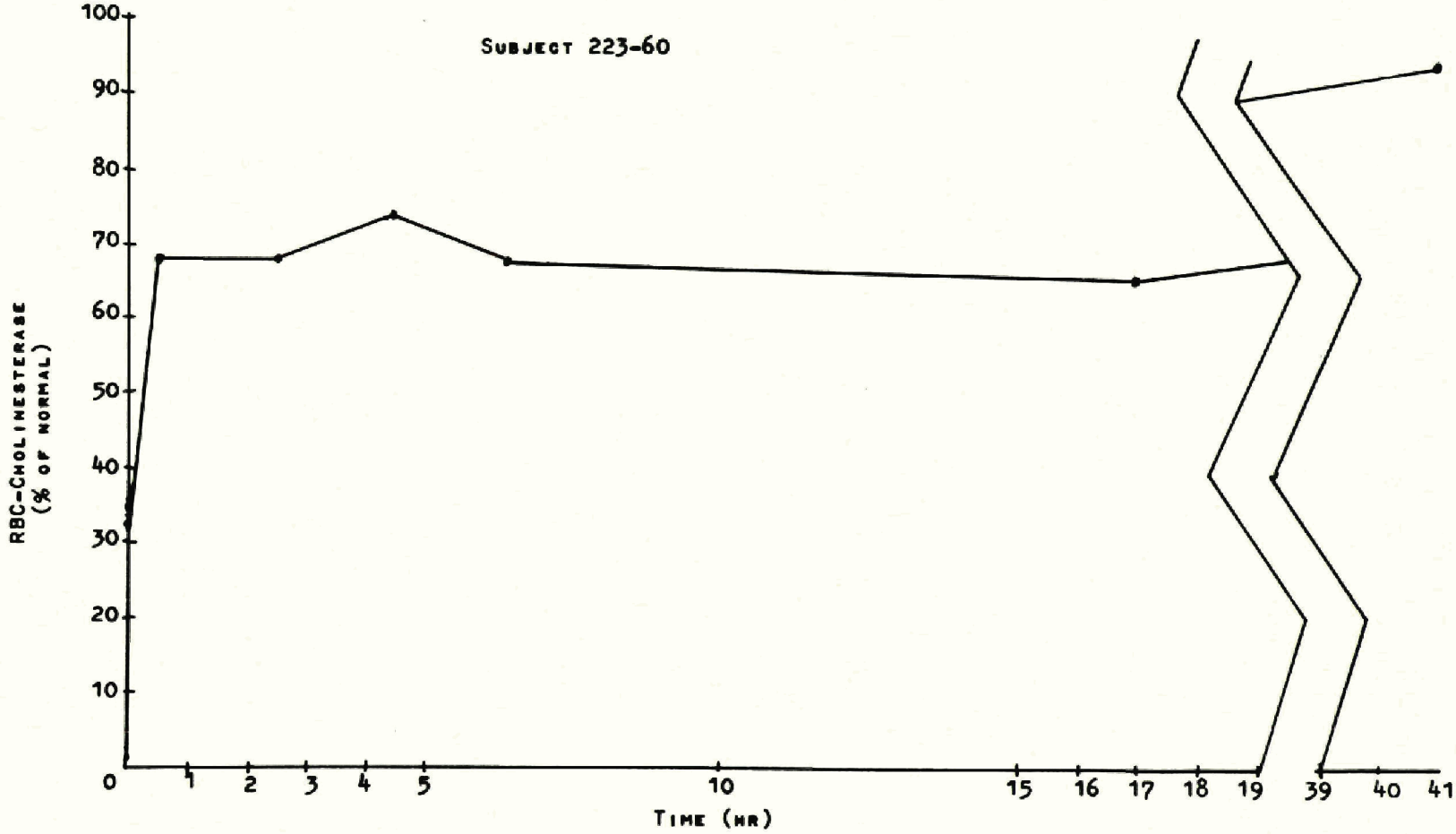


FIGURE 10

EFFECT OF OXIME ON CHOLINESTERASE DEPRESSED BY PERCUTANEOUSLY APPLIED VX

0.5 GM PAM-CL ADMINISTERED INTRAVENOUSLY AT 0 TIME.
0 TIME = 6 HR AFTER APPLICATION OF 5 µG/KG TO CHEEK.

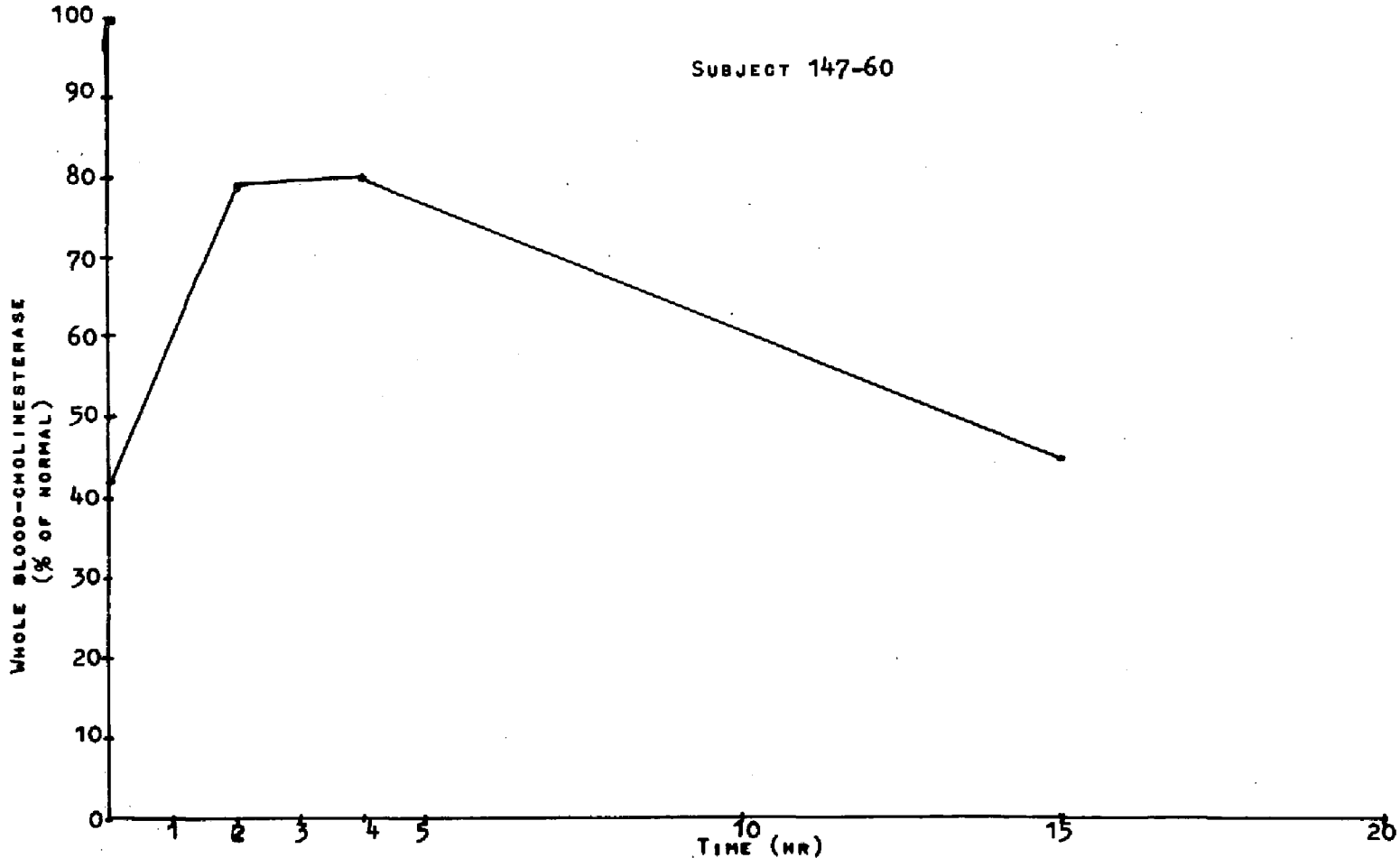


FIGURE 11

EFFECT OF OXIME ON CHOLINESTERASE DEPRESSED BY PERCUTANEOUSLY APPLIED VX

1 GM PAM-CL ADMINISTERED INTRAVENOUSLY AT 0 TIME.
0 TIME = 8 HR AFTER APPLICATION OF 20 µG/KG TO BACK OF NECK.

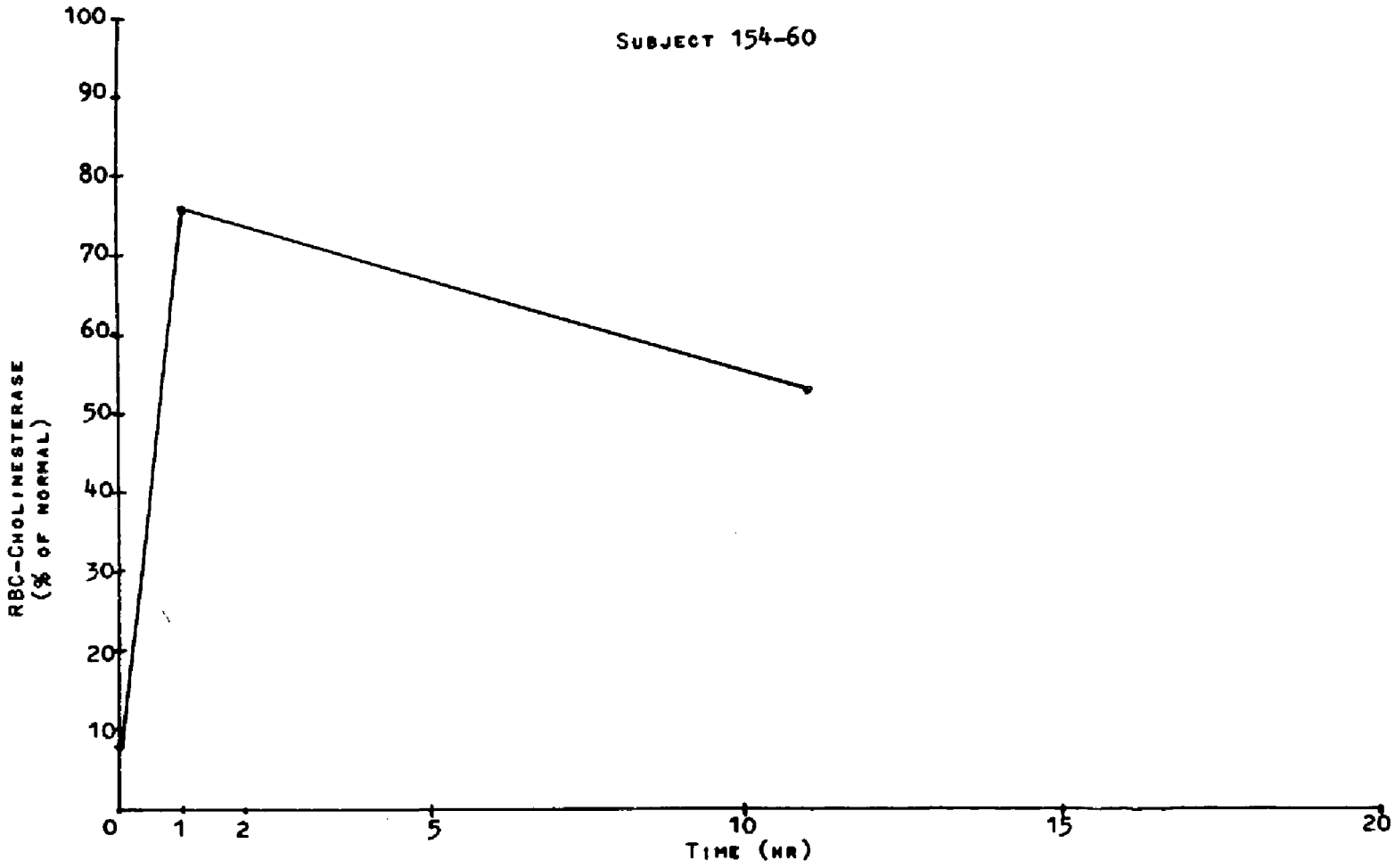


FIGURE 12

EFFECT OF OXIME ON CHOLINESTERASE DEPRESSED BY PERCUTANEOUSLY APPLIED VX

5 GM PAM-CL ADMINISTERED INTRAVENOUSLY AT 0 TIME.
0 TIME = 10 HR AFTER APPLICATION OF 20 µG/KG TO BACK.

It was thought that the permeability of the skin in a given area could be computed by using the following formula:

$$\frac{\text{Amount of agent penetrating}}{(\text{Area exposed})\ (\text{Time of exposure})} = k$$

Since the size of the area exposed was changing (because of drop spread or contraction), the cumulative product of area exposed x time of exposure was calculated. By extrapolating from the previous estimate that 1 μg/kg of VX has entered the blood stream when a ChE50 is reached,[6] the amount of agent penetrating was calculated.

The significance of the regression coefficients that resulted from this analysis are listed in table 4. There is excellent agreement among the significance of these coefficients for RBC-, plasma-, and whole-blood-ChE for each time of reading. These data show that the earlier the measurement of spread was taken, the more reliably the calculated penetration rate predicted the rate of cholinesterase drop This suggests that the size of the area covered by agent is a good predictor of penetration rate shortly after exposure, but a poor predictor as time progresses.

H. Probit Dose-Response Slope for VX Applied to Volar Forearm of Man.

The probit dose-response slope for VX applied to the volar forearm was calculated by the method of Bliss[7] for each of the three blood components (RBC, whole blood, and plasma). The data used were those reported by Sim and Stubbs[1] on ChE depression after application of 5, 10, 15, 20, and 35 μg/kg of VX to the volar forearm and the current data on 20 μg/kg applied to the same area. The values that resulted are shown in table 5.

I. Percutaneous Dose of VX Necessary to Produce a ChE30.

The probit dose-response slopes listed in table 5 were assumed to hold for application of VX to all sites on the body.* From these slopes and the recorded ChE levels for each body site, the dose necessary to produce a ChE30 in each of the blood components was estimated. These doses are listed in rank order in table 6.** In every instance, the cheek,

* See Discussion for the effect of this assumption on calculations.

** Values for some areas will not be found in tables 6 and 7 because ChE depression in one or more blood components was not determined.

TABLE 4

SIGNIFICANCE OF REGRESSION COEFFICIENTS OF DROP IN CHOLINESTERASE PER MINUTE VERSUS PREDICTED PENETRATION RATE

(As Predicted by Their Associated Correlation Coefficients)

Time spread measurement taken after application of agent	Correlation coefficient		
	RBC	Plasma	Whole blood
min			
10	0.612*	0.654*	0.624*
60	0.424	0.499*	0.433
180	0.301	0.383	0.365
360	0.220	0.291	0.323

* Statistically significant.

TABLE 5

PROBIT-DOSE RESPONSE SLOPE FOR VX APPLIED TO THE VOLAR FOREARM OF MAN

Blood component	Dose for ChE30	Dose for ChE50	Probit-dose response slope
	μg/kg		
RBC	40	24	2.350
Plasma	133	58	1.448
Whole blood	50	26	1.838

TABLE 6

ESTIMATED PERCUTANEOUS DOSE OF VX NECESSARY TO PRODUCE A ChE30

Single-drop dose of VX					
Area of application	RBC	Area of application	Whole blood	Area of application	Plasma
	µg/kg		µg/kg		µg/kg
1. Cheek	5.1	1. Cheek	5.9	1. Cheek	21.1
2. Ear	6.6	2. Ear	6.0	2. Ear	40.4
3. Top of head	10.8	3. Forehead	12.6	3. Top of head	40.4
4. Forehead	11.2	4. Top of head	16.0	4. Forehead	44.6
5. Groin	17.4	5. Back of neck	27.8	5. Groin	47.7
6. Back of neck	24.6	6. Popliteal space	30.5	6. Back of neck	63.3
7. Axilla	29.6	7. Groin	32.0	7. Popliteal space	79.1
8. Popliteal space	29.9	8. Axilla	42.3	8. Hand (dorsum)*	96.7
9. Abdomen	31.8	9. Elbow	46.4	9. Abdomen	116.0
10. Elbow	32.2	10. Forearm (volar)	50.0	10. Forearm (dorsum)	126.0
11. Back	37.9	11. Abdomen	51.8	11. Axilla	127.0
12. Forearm (volar)	40.0	12. Back	56.3	12. Forearm (volar)	133.0
13. Hand (dorsum)	41.5	13. Forearm (dorsum)*	61.8	13. Back	143.0
14. Forearm (dorsum)*	43.4	14. Buttocks	84.0	14. Foot (dorsum)	171.0
15. Buttocks	60.9	15. Knee	151.0	15. Forearm (dorsum)*	185.0
16. Forearm (dorsum)	93.8	16. Forearm (dorsum)	164.0	16. Hand (palmar)	206.0
17. Foot (dorsum)	94.3	17. Foot (plantar)	217.0	17. Foot (plantar)	220.0
18. Foot (plantar)	102.0	18. Hand (palmar)	233.0	18. Elbow	274.0
19. Knee	102.0	19. Foot (dorsum)	306.0	19. Knee	297.0
20. Hand (palmar)	132.0			20. Hand (dorsum)	428.0
				21. Buttocks	598.0

* Applied as 5 discrete droplets.

ear, forehead, and top of head required the least amount of percutaneously applied VX to produce a ChE30.

J. Estimated Penetration Rates of VX From Different Skin Sites.

1. Based on Recorded ChE Values.

Depression of ChE observed in the current studies was used to estimate the total amount of VX that penetrated (assuming the weight of subjects was 70 kg in all cases), using the following formula:

$$\text{Probit \% ChE} = a + b \log \text{dose}$$

where

a = intercept

b = slope

Assuming from intravenous studies[6] that 1 μg/kg of VX has entered the blood stream when a ChE50 is reached, and substituting 5.000, the probit for 50% ChE,

$$5.000 = a + b \log (1)$$

or

$$5.000 = a + b (0)$$

$$a = 5.000 \text{ regardless of the slope}$$

and

$$\text{Log dose} = \frac{5.000 - \text{probit \% ChE}}{\text{Slope}}$$

The product of period of exposure (in minutes) x area covered by VX (in square centimeters) was accumulated at several times to obtain the area under the curve of time x area. Since the units of this product are square centimeter minutes, dividing the total amount of agent that penetrated by the product of time x area gave the estimated penetration rate. The values derived are listed in rank order of penetration rate in table 7. Top of head, ear, cheek, and forehead were again the most sensitive to penetration.

TABLE 7

ESTIMATED PENETRATION RATE OF PERCUTANEOUS SINGLE-DROP APPLICATIONS OF VX BASED ON DEPRESSION OF RED-BLOOD-CELL, WHOLE-BLOOD, AND PLASMA CHOLINESTERASES

Area of application	RBC-ChE			Area of application	Whole-blood-ChE			Area of application	Plasma-ChE		
	Total VX penetration	Area x time	Penetration rate		Total VX penetration	Area x time	Penetration rate		Total VX penetration	Area x time	Penetration rate
	μg	sq cm min	μg/sq cm min		μg	sq cm min	μg/sq cm min		μg	sq cm min	μg/sq cm min
1. Ear	94	458	0.206	1. Ear	126	458	0.274	1. Top of head	18	350	0.052
2. Top of head	57	350	0.164	2. Cheek	131	914	0.141	2. Ear	18	458	0.040
3. Cheek	122	914	0.133	3. Top of head	48	350	0.138	3. Cheek	35	914	0.038
4. Forehead	111	1,018	0.108	4. Forehead	121	1,018	0.119	4. Forehead	33	1,018	0.032
5. Elbow	77	1,673	0.046	5. Elbow	66	1,673	0.039	5. Groin	32	2,031	0.016
6. Axilla	84	2,061	0.041	6. Forearm (volar)	61	1,595	0.038	6. Forearm (volar)	21	1,595	0.013
7. Forearm (volar)	62	1,595	0.039	7. Axilla	72	2,061	0.035	7. Axilla	24	2,061	0.012
8. Groin	72	2,031	0.035	8. Popliteal space	100	3,247	0.031	8. Popliteal space	37	3,247	0.011
9. Popliteal space	83	3,247	0.026	9. Back of neck	110	4,638	0.024	9. Back of neck	47	4,638	0.010
10. Back of neck	102	4,638	0.022	10. Groin	48	2,031	0.023	10. Foot (plantar)	13	1,697	0.0077
11. Abdomen	78	4,473	0.018	11. Abdomen	59	4,473	0.013	11. Hand (palmar)	15	1,902	0.0077
12. Foot (plantar)	24	1,697	0.0144	12. Foot (plantar)	14	1,697	0.0083	12. Elbow	10	1,673	0.0063
13. Back	66	6,663	0.0099	13. Back	54	6,663	0.0081	13. Abdomen	26	4,473	0.0058
14. Head (palmar)	19	1,902	0.0099	14. Knee	20	2,503	0.0080	14. Foot (dorsum)	18	3,915	0.0047
15. Knee	24	2,503	0.0098	15. Buttocks	36	4,570	0.0079	15. Knee	10	2,503	0.0039
16. Buttocks	41	4,570	0.0088	16. Hand (palmar)	13	1,902	0.0068	16. Back	21	6,663	0.0031
17. Foot (dorsum)	27	3,915	0.0068	17. Foot (dorsum)	10	3,915	0.0025	17. Buttocks	5	4,570	0.0011

2. Based on Per Cent Symptoms.

Penetration rates based on the criterion of per cent symptoms were calculated where possible. The calculation was similar to that for penetration rates based on recorded RBC-ChE values, the only difference being it was assumed that a ChE30 had been reached (and 1.71 μg/kg of VX was in the blood stream) when 50% of a group exhibited symptoms. The predicted penetration rates are shown in table 8. The head and neck areas again are the most sensitive to penetration.

IV. DISCUSSION.

This study indicates that there is individual variability in susceptibility to percutaneously applied VX, and there is also a variability in penetration rate that depends on the anatomic site to which the agent is applied. Table 9 shows that whether drop in ChE or toxic symptomatology is considered, the head and neck areas are the most sensitive to percutaneously applied VX. More than half the subjects who received the agent (5 to 20 μg/kg) on the head and neck areas exhibited gastrointestinal disturbances ranging from nausea to repeated vomiting and diarrhea, while only 8% of those exposed on the extremities (20 to 30 μg/kg) and 16% of those exposed on the body (10 to 20 μg/kg) became ill. This evidence further suggests that although the percutaneous-to-intravenous dose ratio for a ChE30 is 20:1 for the volar surface of the forearm, it is 5:2 for the ear and face.

The finding that the head and neck are extremely penetrable is particularly relevant to the design of protective equipment, emphasizing the necessity of an effective covering for the head and neck. It further emphasizes the need for effective decontaminants and decontamination procedures.

The estimates of penetration rate and percutaneous dose of VX necessary to produce a ChE30 are by no means precise. They are submitted only as being the best estimates possible from the data now available. One source of error in the computations was the assumption that the probit dose-response slope for VX applied to the volar surface of the forearm was also the slope for all other sites on the body. This is contradictory to the finding that ChE depression and toxic symptomatology vary in severity from one site on the body to another, and the reasonable inference that this reflects a variation in penetration rate. To obtain a true probit dose-response slope for each skin site would require the exposure of several subjects to different doses on the same site, repeated for all 19 sites studied. Considerable time and effort would be involved. Future studies will be designed to provide data for the calculation of a probit dose-response slope for the least sensitive

TABLE 8

ESTIMATED PENETRATION RATE OF PERCUTANEOUS SINGLE-DROP APPLICATIONS OF VX BASED ON PER CENT OF SUBJECTS WITH SYMPTOMS

Area	Symptoms	Estimated total penetration of VX	Area x time	Penetration rate
	%	μg	sq cm min	μg/sq cm min
Ear	62.5	228	458	0.498
Forehead	75.0	324	1,018	0.318
Top of head	25.0	71	350	0.203
Cheek	50.0	167	914	0.183
Back of neck	75.0	324	4,638	0.070
Forearm (volar)	14.3	59	1,595	0.037
Axilla	16.6	65	2,061	0.032
Abdomen	37.5	122	4,473	0.027
Popliteal space	12.5	54	3,247	0.017
Buttocks	12.5	54	4,570	0.012
Back	12.5	54	6,663	0.008

TABLE 9

COMPARISON BY GENERAL ANATOMICAL SITE OF EFFECTS OF PERCUTANEOUSLY APPLIED VX

General anatomical site	Subjects with ChE drop to 50% or less	Subjects with moderately severe symptoms*
	%	
Extremities	23	8
Body	37	16
Head and neck	80	54

* Nausea, vomiting, and weakness

and the most sensitive areas. Then a more valid extrapolation of the intermediate slopes can be made.

It is believed, however, that estimates of penetration rate and dose necessary to produce a ChE30 are conservative for those sites that were relatively more sensitive to penetration than the volar surface of the forearm. For those sites that were relatively less sensitive, not only does the slope used introduce significant error, but the fact that very little ChE depression occurred at the dosages used made almost meaningless the extrapolation of the very flat slope to a dose where ChE depression would be significant. These estimates are included in this report only to show, regardless of the assumptions made, the relative order of sensitivity to penetration by VX was essentially the same in every calculation.

It was also found that whether the criterion for calculating penetration was actual ChE depression or onset of symptoms, the results were the same. This would validate the previous assumptions that ChE depression and symptoms are directly correlated.

Although RBC-ChE depression has been the basis for most of the observations made in this report and the correlation between RBC- and whole-blood-ChE levels has not been statistically analyzed, a comparison of the values listed in the appendix reveals that the appendix per cent of whole-blood-ChE depression closely parallels per cent of RBC-ChE depression. This suggests that if a reliable method for determining whole-blood-ChE were incorporated in field kits, results would be as good an index of poisoning as more complex methods of measuring RBC-ChE.

Two clinical observations should be discussed. The first is the indication that a small amount of VX (5 μg/kg) can produce sufficient vapor to cause unilateral miosis when the contamination is on the face. In the three instances of unilateral miosis, sweating of the area of application was observed. In other instances when VX was applied to the face and no sweating was observed, miosis did not occur.

The second observation is that relatively rapid penetration of the agent (5 hr) with a resultant rapid fall in ChE activity was associated with more severe symptomatology than slow penetration (10 hr), even though total drop in ChE was almost the same. An explanation for this may be that metabolism and destruction of the agent are larger factors in the longer time intervals. It must be stressed that this observation pertains only to percutaneous application of VX, because time/dose/effect relationships have not yet been firmly established in man for sublethal doses of VX or G agents by the intravenous and inhalation routes.

V. CONCLUSIONS.

The following conclusions were reached:

1. ChE depression by sublethal doses of VX and incidence of symptoms are directly correlated.

2. There is a difference in sensitivity to penetration by VX of various body sites, the head and neck areas being the most sensitive.

3. The more rapid the penetration rate, the more rapid is the onset of toxic signs and symptoms.

4. Oximes appear to be effective in the treatment of VX intoxication.

LITERATURE CITED

1. Sim, V. M., and Stubbs, J. L. CRDLR 3015. VX Percutaneous Studies in Man (U). August 1960. CONFIDENTIAL Report.

2. Stubbs, J. L., and Fales, J. T. A Capillary Sampling Technique for the Determination of Cholinesterase Activity in Red Cells and Plasma. Am. J. Med. Technol. 26, 25 (1960).

3. Einsel, D. W., et al. Self-Equilibrating Electrolytic Method for the Determination of Acid Production Rates. Anal. Chem. 28, 408 (1956).

4. Hestrin, S. The Reaction of Acetylcholine and Other Carboxylic Acid Derivations With Hydroxylamine and Its Analytical Application. J. Biol. Chem. 180, 249 (1949).

5. Sim, V. M. Unpublished results.

6. Kimura, K. K., McNamara, B. P., and Sim, V. M. CRDLR 3017. Intravenous Administration of VX in Man. July 1960. FOR OFFICIAL USE ONLY Report.

7. Bliss, C. I. The Statistics of Bioassay. Academic Press, Inc., New York. 1952.

APPENDIX

TABLE

EFFECT ON MAN OF SINGLE DROP AND OF 5 DROPS OF NEAT VX LABELED WITH 1% HILTAMINE

Subject	Race	Age	Weight	Surface area covered by agent			Cholinesterase												Local and systemic signs and symptoms and treatment
							RBC			Plasma					Whole blood				
				Initial	Maximum	Spread	Control	Maximum drop to within 12 hr		At 24 hr		Control	Maximum drop to within 12 hr		At 24 hr		Control	Maximum drop to within 12 hr		At 24 hr		
			kg	sq cm			ΔpH	ΔpH	% of control	ΔpH	% of control	ΔpH	ΔpH	% of control	ΔpH	% of control	μeq/ml	μeq/ml	% of control	μeq/ml	% of control	
EXTREMITIES								20 μg/kg, single drop, percutaneous application on forearm (volar)														
77-60	W	24	79	10.3	13.1	+2.8	0.69	0.21 (12)	30	0.25	36	0.88	0.66 (8)	75	0.68	77	6.7	2.7 (10)	40	2.4	35	None
78-60	W	20	63	9.0	10.1	+1.1	0.62	0.52 (12)	84	0.52	84	0.71	0.67 (10)	94	0.71	100	6.1	4.6 (12)	75	5.3	87	None
79-60	W	22	74	9.2	10.6	+1.4	0.64	0.12 (12)	19	0.19	30	0.81	0.42 (12)	52	0.51	63	6.7	1.2 (6)	18	1.8	25	Nausea; weak; administered 4 mg of atropine im
80-60	W	21	83	16.2	17.0	+0.8	0.73	0.54 (8)	74	0.41	56	0.77	0.70 (10)	91	0.68	88	6.7	4.8 (8)	72	4.3	64	None
81-60	W	28	73	7.8	8.0	+0.2	0.88	0.19 (2)	22	0.40	46	0.81	0.37 (6)	46	0.50	62	6.7	1.7 (10)	25	2.9	42	Nausea; vomited 10 times; administered 8 mg of atropine im, 800 mg of PAM-Cl orally, 500 mg of PAM-Cl im
82-60	W	20	60	8.8	9.8	+1.0	0.72	0.63 (8)	88	0.55	76	0.94	0.74 (8)	79	1.00	106	6.1	4.3 (6)	69	4.4	72	None
83-60	N	21	84	7.6	11.2	+3.6	0.68	0.19 (8)	28	0.20	29	0.66	0.52 (8)	79	0.50	76	5.1	1.4 (8)	28	1.2	24	Vomited
84-60	W	18	68	11.2	11.6	+0.4	0.79	0.70 (8)	89	0.66	84	0.60	0.53 (3)	88	0.70	117	6.3	4.9 (8)	78	5.0	81	None
1-60	W	21	75	13.5	10.5	-3.0	0.73	0.21 (12)	29	0.25	34	0.65	0.58 (10)	89	0.62	95	6.1	1.6 (12)	27	-	-	None
2-60	W	22	75	16.3	13.9	-2.4	0.72	0.27 (12)	38	0.26	36	0.68	0.56 (10)	82	0.48	71	6.0	2.4 (10)	40	-	-	Increased bowel sounds; nausea; administered 30 mg orally of Pro-Banthine Bromide
19-59	W	21	80	-	-	-	0.99	0.63 (11)	64	0.60	61	1.00	0.63 (10)	63	0.87	87	6.2	4.4 (8)	71	3.7	58	None
23-59	W	21	80	-	-	-	0.91	0.39 (8)	43	0.23	25	0.81	0.74 (7)	91	0.71	88	6.7	2.0 (5)	30	3.4	50	None
33-60	W	21	73	2.2	7.6	+5.4	0.80	0.70 (11)	88	0.74	92	0.51	0.39 (5)	76	0.63	123	4.4	4.4 (5)	100	4.7	106	None
34-59	W	29	93	2.6	5.9	+3.3	0.90	0.65 (8)	72	0.70	78	0.70	0.44 (4)	63	0.83	120	6.2	5.0 (10)	81	4.9	79	None
Average			76			+1.21		(9.4)	55		55		(7.9)	76		91		(8.4)	54		60	
								25 μg/kg, single drop, percutaneous application on forearm (dorsum)														
87-60	W	24	86	12.9	14.8	+1.9	0.71	0.52 (10)	73	0.42	59	0.87	0.62 (10)	71	0.66	76	5.2	4.0 (10)	77	3.0	58	None
89-60	W	21	72	13.3	16.0	+2.7	0.82	0.69 (8)	84	0.66	80	0.89	0.75 (4)	84	0.63	71	6.2	5.2 (10)	84	5.2	84	None
91-60	W	25	70	5.1	12.4	+7.3	0.83	0.63 (10)	76	0.64	77	0.91	0.55 (10)	60	0.50	55	6.5	5.5 (6)	85	5.5	85	Slight headache
92-60	W	23	71	9.6	13.2	+3.6	0.67	0.52 (10)	78	0.32	48	0.65	0.44 (10)	68	0.30	46	5.5	4.3 (10)	78	3.5	63	None
Average		23.25	74.8			+3.9		(9.5)	78		66		(8.5)	71		62		(9)	81		73	
								25 μg/kg, 5 drops, percutaneous application on forearm (dorsum)														
96-60	N	19	67	12.9	15.9	+3.0	0.78	0.71 (8)	91	0.78	100	0.91	0.79 (4)	87	0.97	107	5.6	5.5 (6)	98	5.5	98	None
97-60	W	25	72	16.6	18.4	+1.8	0.75	0.18 (10)	24	0.23	31	0.79	0.59 (6)	75	0.57	72	6.1	1.4 (10)	23	1.4	23	Weak; weird dreams; increased bowel sounds; administered 4 mg of atropine im
99-60	W	23	102	31.4	39.4	+8.0	0.87	0.51 (6)	59	0.51	59	0.81	0.60 (6)	74	0.79	98	6.7	4.5 (10)	67	3.7	56	Headache
100-60	W	21	69	19.8	21.7	+1.9	0.62	0.14 (12)	23	0.20	32	0.49	0.38 (12)	78	0.39	80	4.8	1.4 (12)	40	1.5	31	Nightmares
Average		22	77.5			+3.7		(9)	49		56		(7)	78		89		(9.5)	57		52	
								20 μg/kg, single drop, percutaneous application on elbow														
255-60	W	21	89	3.0	6.7	+3.7	50.6†	18.3† (8)	36	2.8†	6	40.4†	30.8† (8)	69	27.7†	69	5.6	1.8 (8)	32	1.4	25	None
256-60	W	18	75	3.2	7.0	+3.8	46.6†	28.0† (12)	60	16.7†	36	45.3†	40.6† (10)	90	40.0†	88	4.8	3.0 (8)	63	1.9	40	None
10-61	W	22	71	2.5	5.5	+3.0	113.1†	88.1† (12)	78	92.2†	82	85.3†	83.1† (8)	97	86.9†	102	6.8	4.1 (12)	60	4.8	71	Itching of spot
1-61	W	43	72	2.5	4.6	+2.1	-	-	-	-	-	-	-	-	-	-	6.2	4.5 (12)	73	3.9	63	None
13-61	W	31	94	2.4	5.2	+2.8	90.9†	25.6† (12)	28	23.1†	25	62.2†	54.4† (12)	87	51.6†	83	5.6	2.3 (12)	41	2.1	38	None
14-61	W	19	58	1.8	3.8	+2.0	86.9†	25.5† (8)	27	-	-	54.4†	50.0† (8)	92	53.1†	98	4.5	1.9 (8)	42	1.7	38	None
Average		26	76.5			+2.9		(10.4)	46		37		(9.1)	87		88		(10)	52		46	
								20 μg/kg, single drop, percutaneous application on hand (palmar)														
182-60	W	20	84	2.7	9.6	+6.9	0.73	0.68 (4)	93	0.82	112	0.64	0.58 (2)	91	0.70	109	5.7	4.6 (8)	81	5.5	96	None
186-60	W	24	84	1.5	5.8	+4.3	0.82	0.73 (4)	89	0.79	96	0.95	0.77 (4)	81	0.79	83	6.3	5.7 (6)	90	-	-	None
188-60	W	21	85	2.5	5.7	+3.2	0.64	0.59 (6)	92	0.78	122	0.46	0.43 (12)	93	0.52	113	5.7	5.5 (8)	96	-	-	None
189-60	N	33	79	2.1	5.3	+3.2	0.63	0.62 (6)	98	0.74	117	0.61	0.47 (8)	77	0.50	82	6.0	5.1 (10)	85	-	-	None
183-60	W	19	65	1.7	4.5	+2.8	0.69	0.65 (6)	94	0.76	110	0.81	0.62 (6)	77	0.91	112	5.5	5.2 (12)	95	5.1	93	Spot sweating
184-60	W	20	83	1.6	4.4	+2.8	0.78	0.73 (4)	94	0.87	112	0.68	0.73 (8)	107	0.63	93	6.3	6.3 (-)	100	6.3	100	Spot sweating
185-60	N	22	63	1.9	4.6	+2.7	0.64	0.54 (4)	84	0.70	109	0.77	0.58 (10)	75	0.57	74	5.4	5.1 (10)	94	-	-	None
187-60	W	24	85	2.2	7.4	+5.2	0.70	0.58 (6)	83	0.69	99	0.77	0.55 (10)	71	0.70	91	5.7	5.1 (10)	89	-	-	None
Average		23	78.5			+3.9		(5)	91		110		(7.5)	84		95		(8)	91		96	
								30 μg/kg, single drop, percutaneous application on hand (dorsum)														
136-60	N	22	66	7.8	10.4	+2.6	0.70	0.69 (6)	99	0.67	96	0.82	0.69 (2)	84	0.81	99	50	46† (2)	92	51†	102	None
137-60	W	34	64	3.9	6.9	+3.0	0.71	0.66 (10)	93	0.75	106	0.91	0.87 (4)	96	1.14	125	53	51† (8)	96	52†	98	None
138-60	W	22	66	7.0	10.4	+3.4	0.72	0.75 (8)	104	0.75	104	0.97	0.79 (4)	81	0.95	98	55	50† (2)	91	52†	95	None
139-60	N	33	94	5.9	9.2	+3.3	0.75	0.61 (8)	81	0.64	85	0.75	0.70 (6)	93	0.78	104	52	48† (6)	92	48†	92	None
Average		28	73			+3.1		(8)	94		98		(4)	89		107		(5)	93		97	
								20 μg/kg, 5 drops, percutaneous application on hand (dorsum)														
29-60	W	22	80	74.1	77.8	+3.7	0.77	0.50 (10)	65	0.51	66	0.77	0.10 (10)	13	0.80	104	-	-	-	-	-	None
30-60	W	29	70	93.7	99.4	+5.7	0.80	0.57 (10)	71	0.32	40	0.77	0.60 (10)	78	0.74	96	-	-	-	-	-	None
31-60	W	21	65	101.7	108.1	+6.4	0.86	0.55 (10)	64	0.39	45	0.67	0.51 (10)	76	0.66	99	-	-	-	-	-	None
32-60	W	18	60	77.4	81.4	+4.0	0.61	0.11 (10)	18	0.13	21	0.73	0.41 (10)	56	0.44	60	-	-	-	-	-	Headache; nausea; administered 2 mg of atropine im
33-60	W	32	71	84.4	88.9	+4.5	0.76	0.51 (10)	67	0.41	54	0.69	0.58 (10)	84	0.77	112	-	-	-	-	-	None
34-60	N	28	73	86.9	85.6	-1.3	0.76	0.51 (10)	67	0.41	54	0.69	0.58 (10)	84	0.77	112	-	-	-	-	-	None
35-60	N	18	70	94.2	103.5	+9.3	0.83	0.60 (8)	72	0.51	61	0.66	0.53 (10)	80	0.73	111	-	-	-	-	-	None
36-60	W	20	76	69.0	68.3	-0.7	0.77	0.20 (10)	26	0.21	27	0.74	0.65 (8)	88	0.70	95	-	-	-	-	-	None
Average		23.5	70.6			+3.95		(9.7)	56		46		(9.8)	70		99	-	-	-	-	-	
								20 μg/kg, single drop, percutaneous application on knee														
2-61	N	23	75	3.0	6.2	+3.2	-	- -	-	-	-	-	-	-	-	-	4.7	4.1 (4)	87	4.5	96	None
19-61	W	19	64	3.5	6.0	+2.5	95.9†	91.9† (6)	96	88.8†	93	87.2†	85.9† (2)	99	88.8†	102	5.4	5.4 (-)	100	5.4	100	None
9-61	W	25	89	4.2	9.9	+5.7	113.1†	88.1† (12)	78	92.2†	82	85.3†	83.1† (2)	97	86.9†	102	6.7	4.2 (12)	63	4.3	64	Spot itching
20-61	W	35	64	3.8	9.9	+6.1	113.8†	86.6† (10)	76	68.6†	60	76.6†	64.1† (4)	84	65.9†	86	5.7	4.5 (6)	79	4.2	74	None
257-60	W	23	101	4.7	10.8	+6.1	50.0†	43.5† (12)	87	41.5†	83	46.6†	33.6† (4)	72	46.6†	100	5.2	4.3 (8)	83	5.0	97	None
258-60	W	20	66	3.2	6.2	+3.0	47.2†	44.6† (10)	95	32.6†	69	35.7†	34.1† (10)	96	35.7†	100	4.5	4.0 (10)	89	3.0	67	None
Average		24	76.5			+4.4		(10)	86		77		(4.5)	89		98		(8)	84		83	
								20 μg/kg, single drop, percutaneous application on popliteal space														
224-60	W	20	54	3.4	11.6	+8.2	0.77	0.64 (10)	83	0.64	83	0.64	0.60 (12)	94	0.60	94	5.8	4.2 (10)	72	4.4	76	Spot sweating
225-60	N	19	70	2.9	10.2	+7.3	0.70	0.23 (12)	33	0.25	36	0.69	0.54 (12)	78	0.57	83	5.2	1.6 (10)	31	2.2	40	None
234-60	W	19	70	3.2	8.5	+5.3	0.76	0.20 (12)	26	0.24	32	0.80	0.51 (12)	64	0.45	56	5.3	1.1 (10)	21	1.7	32	None
235-60	W	21	59	2.8	6.5	+3.7	0.70	0.07 (4)	10	0.44	63	0.75	0.40 (6)	53	0.41	55	5.3	1.3 (6)	25	3.5	66	Vomited twice; 0.5 gm of PAM-Cl in 15 ml of saline im
236-60	W	20	84	4.2	13.3	+9.1	0.75	0.32 (12)	43	0.32	43	0.73	0.43 (12)	59	0.48	66	6.0	2.1 (12)	35	2.7	45	None
237-60	W	18	63	2.9	9.3	+6.4	0.72	0.15 (12)	21	0.26	36	0.61	0.40 (12)	66	0.45	74	6.5	0.6 (12)	9	1.0	15	None
226-60	N	26	75	3.5	10.9	+7.4	0.94	0.65 (12)	69	0.43	46	1.45	0.74 (8)	50	0.50	34	6.3	3.9 (8)	62	3.9	62	None
227-60	W	18	72	3.6	10.5	+6.9	0.83	0.50 (10)	60	0.42	51	0.85	0.50 (8)	59	0.45	53	5.0	2.8 (10)	56	-	-	None
Average		20.1	68.3			+6.8		(10.5)	43		49		(10.25)	65		64		(9.75)	39		48	
								20 μg/kg, single drop, percutaneous application on foot (dorsum)														
174-60	N	19	52	1.8	16.0	+14.2	0.70	0.64 (12)	91	0.72	103	0.64	0.64 (6)	100	0.46	72	5.0	4.8 (10)	96	-	-	None
176-60	W	18	71	2.7	14.7	+12.0	0.76	0.64 (10)	84	0.81	107	0.89	0.71 (10)	80	0.90	101	5.5	5.5 (-)	100	-	-	None
178-60	N	23	61	1.9	6.2	+4.3	0.83	0.60 (6)	72	0.80	96	0.73	0.44 (6)	60	0.90	123	5.6	5.0 (4)	89	7.0	125	None
180-60	W	19	65	2.3	11.6	+9.3	1.04	0.86 (6)	83	0.95	91	0.90	0.78 (6)	87	0.86	96	7.0	5.8 (6)	83	7.0	100	None
175-60	N	19	65	2.1	16.8	+14.7	0.85	0.60 (12)	71	0.59	70	0.77	0.67 (10	87	0.72	94	5.5	5.2 (10)	95	-	-	None
177-60	W	21	69	5.3	13.5	+8.2	0.75	0.63 (12)	84	0.64	85	0.73	0.56 (10)	77	0.91	125	5.0	4.7 (8)	94	-	-	None
179-60	W	17	69	1.6	11.2	+9.6	0.78	0.71 (6)	91	0.80	103	1.06	0.77 (6)	73	0.84	79	5.7	5.6 (4)	98	5.7	100	None
181-60	W	21	67	4.4	18.5	+14.1	0.78	0.74 (4)	95	0.76	97	0.63	0.55 (6)	87	0.66	105	5.6	5.2 (6)	93	4.8	86	None
Average		19.6	64.8			+10.8		(8.5)	84		94		(7.5)	81		99		(6.9)	94		103	
								20 μg/kg, single drop, percutaneous application on foot (plantar)														
165-60	W	28	74	3.6	6.9	+3.3	0.76	0.67 (12)	88	0.61	80	0.61	0.49 (12)	80	0.35	57	5.6	5.1 (12)	91	5.6	100	Spot sweating
170-60	W	19	69	1.9	3.0	+1.1	0.73	0.63 (6)	86	0.64	88	0.63	0.50 (2)	79	0.61	97	4.8	4.6 (2)	96	4.8	100	None
171-60	W	25	68	2.0	4.4	+2.4	0.85	0.74 (12)	87	0.81	95	0.65	0.62 (4)	95	0.77	118	5.7	5.2 (6)	91	5.7	100	None
167-60	W	21	62	2.7	3.0	+0.3	0.73	0.62 (12)	85	0.59	81	0.60	0.51 (10)	85	0.46	77	5.0	5.0 (-)	100	5.0	100	None
166-60	N	32	73	3.8	6.0	+2.2	0.70	0.60 (10)	86	0.59	84	0.73	0.62 (12)	85	0.57	78	5.5	4.4 (10)	80	4.9	89	Spot sweating
172-60	N	24	76	2.7	10.8	+8.1	0.84	0.72 (10)	86	0.74	88	0.82	0.65 (8)	79	0.81	99	5.2	5.3 (4)	102	5.7	110	None
173-60	W	20	70	2.0	3.8	+1.8	0.69	0.65 (6)	94	0.67	97	0.71	0.58 (6)	82	0.70	99	5.0	4.7 (2)	94	4.9	98	None
168-60	W	25	72	2.6	4.0	+1.4	0.76	0.60 (12)	79	0.57	75	0.80	0.75 (10)	94	0.76	95	5.5	3.6 (12)	65	5.1	93	Spot sweating
Average		24.2	70.5			+2.6		(10)	86		86		(8)	85		90		(6.8)	90		99	

EFFECT ON MAN OF SINGLE DROP AND OF 5 DROPS OF NEAT VX LABELED WITH 1% HILTAMINE

Subject	Race	Age	Weight	Surface area covered by agent			Cholinesterase														Local and systemic signs and symptoms and treatment
							RBC			Plasma						Whole blood					
				Initial	Maximum	Spread	Control	Maximum drop to within 12 hr		At 24 hr		Control	Maximum drop to within 12 hr		At 24 hr		Control	Maximum drop to within 12 hr		At 24 hr		
			kg	sq cm			ΔpH	ΔpH	% of control	ΔpH	% of control	ΔpH	ΔpH	% of control	ΔpH	% of control	µeq/ml	µeq/ml	% of control	µeq/ml	% of control	
BODY																					
													20 µg/kg, single drop, percutaneous application on buttocks								
157-60	W	24	72	13.3	17.2	+3.9	0.76	0.49 (6)	64	0.44	58	0.67	0.64 (6)	96	0.71	106	5.2	4.0 (10)	77	4.3	83	None
159-60	W	19	66	14.8	19.8	+5.0	0.75	0.62 (8)	83	0.58	77	0.71	0.66 (10)	93	0.68	96	5.3	4.6 (8)	87	4.6	87	Headache; spot itching; administered two APC's
161-60	W	19	72	4.9	14.5	+9.6	0.84	0.51 (12)	61	0.47	56	0.87	0.82 (10)	94	0.79	91	6.4	3.4 (10)	53	4.4	69	None
162-60	W	22	64	3.1	12.0	+8.9	0.79	0.19 (10)	24	0.19	24	0.63	0.45 (12)	71	0.41	65	5.8	1.1 (12)	19	1.6	28	Nausea; vomiting; sweating; administered 15 mg of Pro-Banthine Bromide orally
158-60	W	21	74	17.2	21.6	+4.4	0.79	0.74 (6)	94	0.83	105	0.72	0.71 (6)	99	0.83	115	5.5	5.5 (-)	100	5.5	100	None
160-60	W	24	72	14.8	15.9	+1.1	0.87	0.72 (12)	83	0.49	56	0.71	0.72 (12)	101	0.72	101	6.4	4.8 (12)	75	4.8	75	Spot itching
163-60	W	24	64	3.7	15.3	+11.6	0.84	0.68 (10)	81	0.65	77	0.69	0.80 (8)	116	0.86	125	5.6	4.3 (8)	77	5.0	89	None
164-60	W	23	66	2.8	10.4	+10.4	0.74	0.57 (12)	77	0.45	61	0.84	0.77 (12)	92	0.68	81	5.3	3.9 (12)	74	3.5	66	None
Average		22	68.7			+6.86		(9.5)	71		64		(9.5)	95		98		(10.28)	70		75	
													20 µg/kg, single drop, percutaneous application on back								
149-60	W	21	83	18.9	25.8	+6.9	0.85	0.42 (12)	49	0.38	45	0.86	0.55 (10)	64	0.73	85	6.8	5.2 (8)	76	5.1	75	Nightmares
156-60	N	32	64	18.0	23.1	+5.1	0.87	0.79 (10)	91	0.84	97	0.67	0.54 (4)	81	0.73	109	6.1	5.4 (8)	89	-	-	None
150-60	N	23	67	11.6	15.2	+3.6	0.82	0.30 (12)	37	0.25	30	0.70	0.58 (6)	83	0.54	77	6.2	2.9 (12)	47	2.9	47	Upset stomach; nightmares
154-60	W	21	77	11.3	12.3	+1.0	0.83	0.07 (10)	8	0.44	53	0.72	0.50 (2)	69	0.59	82	5.8	0.4 (10)	7	3.6	62	Vomited six times; nausea; nervous; spot sweating; erythema; fasciculation; cramps; administered 2 mg of atropine im and 5 gm of PAM-Cl in 250 ml of saline iv
151-60	W	22	79	20.5	27.0	+6.5	0.78	0.57 (10)	73	0.48	62	0.95	0.76 (6)	80	0.84	88	5.9	4.7 (6)	80	4.6	79	None
153-60	W	21	76	18.9	23.7	+4.8	0.86	0.52 (12)	60	0.43	50	0.68	0.61 (4)	90	0.70	103	5.8	3.2 (6)	55	-	-	Profuse spot sweating
152-60	N	29	68	13.7	16.5	+2.8	0.75	0.53 (12)	71	0.46	61	0.77	0.67 (6)	87	0.65	84	5.3	4.1 (8)	77	4.1	77	None
155-60	W	23	83	14.1	26.0	+11.9	0.91	0.29 (12)	32	0.37	41	0.61	0.42 (12)	69	0.42	69	5.8	2.0 (8)	34	2.4	41	Erythema; spot sweating
Average		24	74.6			+5.32		(11.25)	53		55		(6.25)	78		87		(8.25)	58		64	
													10 µg/kg, single drop, percutaneous application on groin								
239-60	W	19	62	1.4	4.2	+2.8	0.70	0.24 (12)	34	0.22	31	0.69	0.56 (12)	81	0.45	65	5.0	1.7 (12)	34	1.4	28	None
240-60	W	22	76	2.0	5.1	+3.1	0.70	0.37 (4)	53	0.22	31	0.70	0.45 (4)	64	0.47	67	4.7	2.5 (12)	53	0.7	15	None
243-60	N	22	67	3.0	9.2	+6.2	-	-	-	-	-	-	-	-	-	-	5.3	4.2 (4)	79	4.5	85	None
244-60	W	17	64	2.4	11.6	+9.2	-	-	-	-	-	-	-	-	-	-	5.3	3.4 (12)	64	3.4	64	None
241-60	N	24	69	2.8	5.9	+3.1	0.83	0.43 (4)	52	0.60	72	0.69	0.40 (6)	58	0.54	78	4.7	3.6 (12)	77	2.6	55	None
242-60	W	18	63	2.3	5.3	+3.0	0.74	0.42 (6)	57	0.39	53	0.72	0.54 (2)	75	0.58	81	4.6	1.9 (12)	41	2.6	57	None
245-60	W	23	76	2.5	8.3	+5.8	-	-	-	-	-	-	-	-	-	-	5.2	3.2 (8)	62	3.9	75	None
246-60	N	19	87	1.7	4.8	+3.1	-	-	-	-	-	-	-	-	-	-	4.5	3.9 (10)	87	2.9	64	None
Average		20.5	70.5			+4.53		(6.5)	49		47		(6)	70		73		(10.25)	62		55	
													20 µg/kg, single drop, percutaneous application on axilla								
212-60	W	32	82	2.3	6.8	+4.5	0.86	0.53 (12)	62	0.49	57	0.84	0.68 (4)	81	0.64	76	5.5	4.7 (12)	85	4.1	75	None
216-60	W	52	71	2.9	10.1	+7.2	0.80	0.40 (12)	50	0.40	50	1.01	0.85 (4)	84	1.00	99	6.0	2.8 (10)	47	3.0	50	None
217-60	W	21	82	3.0	9.5	+6.5	0.76	0.40 (12)	53	0.39	51	0.86	0.79 (2)	92	0.74	86	5.8	2.6 (10)	45	1.8	31	None
218-60	W	19	70	1.4	5.6	+4.2	0.80	0.28 (12)	35	0.32	40	1.17	0.86 (12)	74	0.79	68	5.7	2.2 (12)	39	1.7	30	None
213-60	W	20	71	1.6	8.2	+6.6	0.87	0.17 (6)	20	0.58	67	1.19	0.70 (8)	59	0.78	66	5.3	1.9 (6)	35	5.1	96	Vomited 13 times; administered 3 gm of PAM-Cl in 400 ml of saline iv
219-60	W	20	76	1.3	6.1	+4.8	0.74	0.26 (12)	35	0.29	39	1.03	0.65 (12)	63	0.76	74	5.0	2.2 (10)	44	2.6	50	Nightmares
Average		27.3	75.3			+5.63		(11)	43		51		(7)	76		78		(10)	49		55	
													20 µg/kg, single drop, percutaneous application on abdomen								
192-60	W	23	75	4.4	15.3	+10.9	0.69	0.26 (8)	38	0.40	58	0.79	0.71 (8)	90	0.72	91	5.4	1.4 (8)	26	3.5	65	Vomited seven times; administered 1 gm of PAM-Cl in 250 ml of saline iv
193-60	W	24	74	4.4	18.5	+14.1	0.62	0.48 (10)	77	0.49	79	0.74	0.72 (4)	97	1.02	137	7.0	4.7 (12)	67	5.2	74	None
196-60	W	20	79	3.8	12.7	+8.9	0.79	0.21 (12)	27	0.28	35	1.21	0.60 (8)	50	0.67	55	4.8	1.6 (8)	33	1.8	38	Vomited twice
197-60	W	28	93	3.0	19.8	+16.8	0.81	0.59 (12)	73	0.55	68	0.73	0.49 (8)	67	0.50	68	4.8	3.7 (2)	77	4.7	98	None
200-60	N	32	88	4.7	14.7	+10.0	0.61	0.35 (12)	57	0.35	57	0.84	0.64 (6)	76	0.65	77	5.3	4.8 (8)	91	-	-	None
201-60	W	20	70	4.3	13.1	+8.8	0.65	-	-	0.61	94	0.64	0.51 (6)	80	0.58	91	-	-	-	-	-	Headache
204-60	W	20	71	3.6	6.8	+3.2	0.78	0.22 (12)	28	0.19	24	0.64	0.50 (12)	78	0.41	64	5.9	2.4 (10)	41	2.0	34	Vomited twice; weak; nausea
205-60	W	23	102	4.0	16.0	+12.0	0.66	0.12 (12)	18	0.28	42	1.13	0.59 (10)	52	0.69	61	6.3	3.4 (10)	54	3.4	54	Dizzy; nightmares
Average		23.6	81.5			+10.58		(11.14)	45		57		(7.75)	74		81		(8.3)	56		61	
HEAD AND NECK																					
													20 µg/kg, single drop, percutaneous application on back of neck								
140-60	W	21	73	8.8	9.2	+0.4	0.80	0.19 (10)	24	0.22	28	0.94	0.50 (12)	53	0.49	52	5.6	1.7 (10)	30	2.5	45	Vomited three times; nausea; dizzy; hypotension
141-60	W	25	63	10.2	12.5	+2.3	0.79	0.29 (8)	37	0.20	25	0.77	0.46 (10)	60	0.48	62	6.2	2.0 (10)	32	2.4	39	Queasy stomach; sluggish; vomited twice; heavy head
142-60	Mon	22	63	7.8	9.6	+1.8	0.73	0.16 (12)	22	0.27	37	0.95	0.46 (12)	48	0.46	48	5.6	1.7 (8)	30	2.0	36	Nausea; stomach ache; vomiting
143-60	W	26	74	10.9	8.7	-2.2	0.68	0.23 (12)	34	0.24	35	0.70	0.47 (12)	67	0.35	50	5.1	2.0 (10)	40	-	-	Vomited 10 times (attributed to apprehension, rather than agent); administered 1 gm of PAM-Cl in 500 ml of saline iv
144-60	W	20	84	15.5	30.2	+14.7	0.82	0.40 (12)	49	0.27	33	0.75	0.52 (10)	69	0.54	72	6.8	3.0 (12)	44	3.0	44	None
145-60	W	23	75	10.9	14.6	+3.7	0.95	0.29 (12)	31	0.28	29	0.95	0.57 (12)	60	0.73	77	7.1	2.5 (8)	35	3.2	45	Vomited twice, nausea; dizzy
146-60	W	24	64	9.6	11.7	+2.1	0.82	0.45 (10)	55	0.38	46	0.82	0.51 (12)	62	0.58	71	7.1	3.5 (10)	49	3.5	49	None
147-60	W	24	65	-	-	-	0.89	0.28 (4)	31	0.40	45	0.95	0.58 (12)	61	0.52	55	6.8	1.9 (6)	28	3.7	54	Vomited twice; shaky; pale; lightheaded; profuse spot sweating; administered 2 mg of atropine im and 1 gm of PAM-Cl in 250 ml of saline iv
Average		23.1	70.1			+3.25		(10)	35		35		(11.5)	60		61		(9.25)	36		45	
													10 µg/kg, single drop, percutaneous application on forehead								
194-60	W	21	75	1.2	3.4	+2.2	1.01	0.21 (6)	21	0.26	26	0.92	0.59 (8)	64	0.83	90	4.9	1.5 (4)	31	2.4	49	Spot sweating
195-60	W	20	82	1.2	5.2	+4.0	0.98	0.20 (12)	20	0.27	28	1.07	0.66 (8)	62	0.67	63	4.4	1.9 (8)	43	2.6	59	Spot sweating; headache; nausea
198-60	W	19	72	1.5	3.6	+2.1	0.74	0.22 (4)	30	0.29	39	0.68	0.39 (6)	57	0.43	63	6.6	1.7 (4)	26	5.4	82	Vomited once; dizzy; left pupil constricted; fatigue; spot sweating
199-60	W	20	70	1.8	4.1	+2.3	0.64	0.21 (4)	33	0.36	56	0.76	0.52 (10)	68	0.50	66	5.9	2.3 (4)	39	3.2	54	Spot sweating; nausea; dizzy
202-60	W	23	82	1.7	3.4	+1.7	0.71	0.26 (12)	37	0.30	42	0.76	0.60 (4)	79	0.68	90	5.6	2.9 (10)	52	3.0	54	Headache; dreams
203-60	W	26	98	1.6	5.4	+3.8	0.89	0.31 (12)	35	0.27	30	1.08	0.77 (4)	71	0.78	72	6.1	1.7 (6)	28	2.1	34	Vomiting; nightmares
206-60	N	20	64	0.2	1.5	+1.3	0.65	0.37 (6)	57	0.36	55	0.78	0.59 (8)	76	0.58	74	5.6	2.1 (10)	38	-	-	None
207-60	W	24	89	1.0	2.9	+1.9	0.71	0.16 (8)	23	0.15	21	0.97	0.63 (10)	65	0.55	57	6.2	0.6 (10)	10	1.6	26	Vomited six times; nausea; weak; spot sweating
Average		22.3	79			+2.4		(8)	32		37		(7)	68		72		(7)	33		51	
													5 µg/kg, single drop, percutaneous application on top of head								
3-61	W	22	68	0.5	0.9	+0.4	-	- -	-	-	-	-	- -	-	-	-	4.8	3.4 (11)	71	3.4	71	None
8-61	W	23	86	0.6	0.8	+0.2	99.4†	89.1† (10)	90	93.4†	94	88.1†	88.1† (8)	100	99.7†	113	5.1	4.2 (6)	82	4.4	86	None
18-61	W	24	82	0.7	1.2	+0.5	110.3†	43.1† (12)	39	37.2†	34	87.5†	70.6† (12)	81	73.4†	84	6.3	3.2 (8)	51	2.4	38	None
21-61	W	28	76	0.7	1.4	+0.7	83.4†	30.6† (12)	37	20.3*	24	87.2†	49.7† (10)	57	65.6†	75	5.1	1.6 (10)	31	1.7	33	Nausea; vomited seven times; diarrhea; tired
27-61	W	24	64	0.6	1.0	+0.4	93.1†	62.8† (6)	67	-	-	78.8†	57.8† (6)	73	-	-	5.6	4.5 (10)	80	4.8	86	None
28-61	W	19	70	0.5	1.0	+0.5	84.1†	25.0† (12)	30	-	-	50.6†	43.1† (6)	85	-	-	5.0	2.0 (8)	40	2.5	50	Dizzy; spot itching; vomited once; headache
29-61	N	40	62	0.6	1.2	+0.6	108.1†	88.4† (8)	82	-	-	51.6†	43.8† (2)	85	-	-	6.2	4.6 (10)	74	6.2	100	Dizzy
30-61	W	21	64	0.8	1.3	+0.5	71.6†	42.8† (8)	60	-	-	70.6†	57.8† (6)	82	-	-	5.7	3.6 (8)	63	3.3	58	None
Average		25.1	71.5			+0.475		(10)	58		51		(7)	80		91		(9)	62		65	
													5 µg/kg, single drop, percutaneous application on cheek								
220-60	W	20	76	1.3	3.8	+2.5	0.81	0.31 (10)	38	-	-	0.84	0.66 (12)	79	-	-	5.0	2.5 (8)	50	2.2	42	None
221-60	W	20	88	1.3	3.0	+1.7	0.84	0.27 (10)	32	0.25	30	0.63	0.46 (12)	73	0.50	79	5.2	1.9 (4)	37	2.0	38	Momentary paralysis
222-60	W	24	64	1.5	1.8	+0.3	0.77	0.20 (8)	26	0.23	30	0.84	0.60 (8)	71	0.62	74	6.4	1.2 (6)	19	3.0	47	Spot sweating; nausea; vomited twice; dizzy
223-60	W	24	88	1.2	2.5	+1.3	0.77	0.24 (4)	31	0.50	65	0.78	0.56 (2)	72	0.64	82	5.5	0.9 (4)	16	5.1	93	Sweating; weak; dizzy; administered 0.5 gm of PAM-Cl in 9 ml of saline (2.68 M) iv
228-60	W	27	77	1.5	6.6	+5.1	1.01	0.50 (6)	50	0.75	74	1.09	0.54 (8)	50	0.51	47	6.3	2.8 (12)	44	3.3	52	None
238-60	W	33	88	1.0	3.0	+2.0	0.83	0.19 (10)	23	0.22	27	0.74	0.51 (8)	69	0.54	73	5.1	1.2 (12)	24	1.6	31	Nightmares; vomited 8 times
232-60	W	19	70	1.8	4.8	+3.0	0.74	0.21 (4)	28	0.44	59	0.77	0.54 (12)	70	0.59	77	5.7	2.8 (12)	49	3.6	63	None
233-60	W	31	70	1.5	2.4	+0.9	0.73	0.04 (4)	5	0.30	41	0.93	0.47 (4)	51	0.50	54	5.3	1.4 (10)	27	2.1	40	Constricted right pupil; hands numb; tired; nausea; pale
Average		24.7	77.6			+2.1		(7)	29		47		(8.2)	67		69		(8.5)	33		51	
													5 µg/kg, single drop, percutaneous application on ear								
4-61	W	22	64	1.1	2.2	+1.1	-	-	-	-	-	-	-	-	-	-	5.9	0.62 (4)	11	1.9	32	Dizzy; vomited twice
7-61	W	24	81	0.8	1.7	+0.9	105.6†	22.5* (4)	21	82.2	78	86.9	62.8 (6)	72	71.9	83	6.2	1.4 (4)	22	3.6	58	Dizzy; nausea; profuse violent vomiting; weak; administered 1 mg of P_2S (2.07 M) in 9 ml of saline iv and 0.5 mg of atropine im
26-61	W	28	77	1.0	2.7	+1.7	84.1†	22.8* (6)	27	-	-	62.2	50.3 (12)	81	-	-	6.2	2.0 (8)	32	2.0	32	Dizzy; nausea; sweating; 0.5 mg of atropine im
11-61	W	20	61	0.6	1.5	+0.9	90.3†	31.3† (12)	35	29.1	32	105.3	95 (10)	90	95	90	6.5	2.6 (10)	40	2.6	40	Dizzy; nightmares
12-61	W	18	68	0.6	1.4	+0.8	-	-	-	-	-	80	68.4*(12)	86	68.8	86	6.2	2.9 (10)	46	2.9	46	Dizzy; nightmares
17-61	W	23	84	0.9	1.5	+0.6	91.9†	45.9* (12)	50	50.6	55	94.1	78.8 (8)	84	85.9	91	5.6	2.9 (6)	52	3.4	61	None
22-61	W	25	74	1.2	2.9	+1.7	87.8†	10.3 (4)	<10	83.1	95	77.8	47.8 (10)	61	66.3	85	6.2	1.4 (4)	23	4.2	68	Lightheadedness; dizzy; cramps; vomited seven times; administered 1 gm of P_2S (2.07 M) in 10 ml of saline iv
23-61	W	22	86	0.6	2.4	+1.8	102.2†	10.9† (10)	<10	-	-	70.6	60.9 (2)	86	-	-	6.2	2.0 (10)	32	2.7	44	Dizzy; vomited five times; administered 0.4 and 0.5 mg of atropine im first and second days, respectively
Average		22.7	74.3			+1.1		(8)	26		65		(8.6)	80		87		(7)	32		48	

* Figures in parentheses refer to the hours after application at which time minimum values were reached

† These values were determined in micromoles of substrate, rather than ΔpH.

AD_____ Accession No._____

Directorate of Medical Research, U. S. Army Chemical Research and Development Laboratories, Army Chemical Center, Maryland

VARIABILITY OF DIFFERENT INTACT HUMAN-SKIN SITES TO THE PENETRATION OF VX - Van M. Sim

CRDLR 3122, February 1962
Task 4C08-02-022-01, FOR OFFICIAL USE ONLY REPORT

The variability in sensitivity to penetration by VX of anatomically different intact human-skin areas was determined from cholinesterase depression and incidence of symptoms. Probit dose-response slope for VX applied to the volar surface of the forearm was calculated, and preliminary estimates of penetration rate were made.

FOR OFFICIAL USE ONLY

1. VX-Penetration Rate in Man
2. Sensitivity Variation of Different Skin Sites to VX Penetration
3. VX, percutaneous, probit dose-response slope for
4. ChE Depression and Incidence of Symptoms in VX Intoxication, correlation of
5. Man, VX-penetration rate in
6. Symptomatology in VX Intoxication

FOR OFFICIAL USE ONLY

AD_____ Accession No._____

Directorate of Medical Research, U. S. Army Chemical Research and Development Laboratories, Army Chemical Center, Maryland

VARIABILITY OF DIFFERENT INTACT HUMAN-SKIN SITES TO THE PENETRATION OF VX - Van M. Sim

CRDLR 3122, February 1962
Task 4C08-02-022-01, FOR OFFICIAL USE ONLY REPORT

The variability in sensitivity to penetration by VX of anatomically different intact human-skin areas was determined from cholinesterase depression and incidence of symptoms. Probit dose-response slope for VX applied to the volar surface of the forearm was calculated, and preliminary estimates of penetration rate were made.

FOR OFFICIAL USE ONLY

1. VX-Penetration Rate in Man
2. Sensitivity Variation of Different Skin Sites to VX Penetration
3. VX, percutaneous, probit dose-response slope for
4. ChE Depression and Incidence of Symptoms in VX Intoxication, correlation of
5. Man, VX-penetration rate in
6. Symptomatology in VX Intoxication

FOR OFFICIAL USE ONLY

AD_____ Accession No._____

Directorate of Medical Research, U. S. Army Chemical Research and Development Laboratories, Army Chemical Center, Maryland

VARIABILITY OF DIFFERENT INTACT HUMAN-SKIN SITES TO THE PENETRATION OF VX - Van M. Sim

CRDLR 3122, February 1962
Task 4C08-02-022-01, FOR OFFICIAL USE ONLY REPORT

The variability in sensitivity to penetration by VX of anatomically different intact human-skin areas was determined from cholinesterase depression and incidence of symptoms. Probit dose-response slope for VX applied to the volar surface of the forearm was calculated, and preliminary estimates of penetration rate were made.

FOR OFFICIAL USE ONLY

1. VX-Penetration Rate in Man
2. Sensitivity Variation of Different Skin Sites to VX Penetration
3. VX, percutaneous, probit dose-response slope for
4. ChE Depression and Incidence of Symptoms in VX Intoxication, correlation of
5. Man, VX-penetration rate in
6. Symptomatology in VX Intoxication

FOR OFFICIAL USE ONLY

AD_____Accession No._____
Directorate of Medical Research, U. S. Army Chemical Research and Development Laboratories, Army Chemical Center, Maryland
VARIABILITY OF DIFFERENT INTACT HUMAN-SKIN SITES TO THE PENETRATION OF VX - Van M. Sim

CRDLR 3122, February 1962
Task 4C08-02-022-01, FOR OFFICIAL USE ONLY REPORT

The variability in sensitivity to penetration by VX of anatomically different intact human-skin areas was determined from cholinesterase depression and incidence of symptoms. Probit dose-response slope for VX applied to the volar surface of the forearm was calculated, and preliminary estimates of penetration rate were made.

FOR OFFICIAL USE ONLY

1. VX-Penetration Rate in Man
2. Sensitivity Variation of Different Skin Sites to VX Penetration
3. VX, percutaneous, probit dose-response slope for
4. ChE Depression and Incidence of Symptoms in VX Intoxication, correlation of
5. Man, VX-penetration rate in
6. Symptomatology in VX Intoxication

FOR OFFICIAL USE ONLY

AD_____Accession No._____
Directorate of Medical Research, U. S. Army Chemical Research and Development Laboratories, Army Chemical Center, Maryland
VARIABILITY OF DIFFERENT INTACT HUMAN-SKIN SITES TO THE PENETRATION OF VX - Van M. Sim

CRDLR 3122, February 1962
Task 4C08-02-022-01, FOR OFFICIAL USE ONLY REPORT

The variability in sensitivity to penetration by VX of anatomically different intact human-skin areas was determined from cholinesterase depression and incidence of symptoms. Probit dose-response slope for VX applied to the volar surface of the forearm was calculated, and preliminary estimates of penetration rate were made.

FOR OFFICIAL USE ONLY

1. VX-Penetration Rate in Man
2. Sensitivity Variation of Different Skin Sites to VX Penetration
3. VX, percutaneous, probit dose-response slope for
4. ChE Depression and Incidence of Symptoms in VX Intoxication, correlation of
5. Man, VX-penetration rate in
6. Symptomatology in VX Intoxication

FOR OFFICIAL USE ONLY

AD_____Accession No._____
Directorate of Medical Research, U. S. Army Chemical Research and Development Laboratories, Army Chemical Center, Maryland
VARIABILITY OF DIFFERENT INTACT HUMAN-SKIN SITES TO THE PENETRATION OF VX - Van M. Sim

CRDLR 3122, February 1962
Task 4C08-02-022-01, FOR OFFICIAL USE ONLY REPORT

The variability in sensitivity to penetration by VX of anatomically different intact human-skin areas was determined from cholinesterase depression and incidence of symptoms. Probit dose-response slope for VX applied to the volar surface of the forearm was calculated, and preliminary estimates of penetration rate were made.

FOR OFFICIAL USE ONLY

1. VX-Penetration Rate in Man
2. Sensitivity Variation of Different Skin Sites to VX Penetration
3. VX, percutaneous, probit dose-response slope for
4. ChE Depression and Incidence of Symptoms in VX Intoxication, correlation of
5. Man, VX-penetration rate in
6. Symptomatology in VX Intoxication

FOR OFFICIAL USE ONLY

AD_____Accession No._____
Directorate of Medical Research, U. S. Army Chemical Research and Development Laboratories, Army Chemical Center, Maryland
VARIABILITY OF DIFFERENT INTACT HUMAN-SKIN SITES TO THE PENETRATION OF VX - Van M. Sim

CRDLR 3122, February 1962
Task 4C08-02-022-01, FOR OFFICIAL USE ONLY REPORT

The variability in sensitivity to penetration by VX of anatomically different intact human-skin areas was determined from cholinesterase depression and incidence of symptoms. Probit dose-response slope for VX applied to the volar surface of the forearm was calculated, and preliminary estimates of penetration rate were made.

FOR OFFICIAL USE ONLY

1. VX-Penetration Rate in Man
2. Sensitivity Variation of Different Skin Sites to VX Penetration
3. VX, percutaneous, probit dose-response slope for
4. ChE Depression and Incidence of Symptoms in VX Intoxication, correlation of
5. Man, VX-penetration rate in
6. Symptomatology in VX Intoxication

FOR OFFICIAL USE ONLY

AD_____Accession No._____
Directorate of Medical Research, U. S. Army Chemical Research and Development Laboratories, Army Chemical Center, Maryland
VARIABILITY OF DIFFERENT INTACT HUMAN-SKIN SITES TO THE PENETRATION OF VX - Van M. Sim

CRDLR 3122, February 1962
Task 4C08-02-022-01, FOR OFFICIAL USE ONLY REPORT

The variability in sensitivity to penetration by VX of anatomically different intact human-skin areas was determined from cholinesterase depression and incidence of symptoms. Probit dose-response slope for VX applied to the volar surface of the forearm was calculated, and preliminary estimates of penetration rate were made.

FOR OFFICIAL USE ONLY

1. VX-Penetration Rate in Man
2. Sensitivity Variation of Different Skin Sites to VX Penetration
3. VX, percutaneous, probit dose-response slope for
4. ChE Depression and Incidence of Symptoms in VX Intoxication, correlation of
5. Man, VX-penetration rate in
6. Symptomatology in VX Intoxication

FOR OFFICIAL USE ONLY

AD_____Accession No._____
Directorate of Medical Research, U. S. Army Chemical Research and Development Laboratories, Army Chemical Center, Maryland
VARIABILITY OF DIFFERENT INTACT HUMAN-SKIN SITES TO THE PENETRATION OF VX - Van M. Sim

CRDLR 3122, February 1962
Task 4C08-02-022-01, FOR OFFICIAL USE ONLY REPORT

The variability in sensitivity to penetration by VX of anatomically different intact human-skin areas was determined from cholinesterase depression and incidence of symptoms. Probit dose-response slope for VX applied to the volar surface of the forearm was calculated, and preliminary estimates of penetration rate were made.

FOR OFFICIAL USE ONLY

1. VX-Penetration Rate in Man
2. Sensitivity Variation of Different Skin Sites to VX Penetration
3. VX, percutaneous, probit dose-response slope for
4. ChE Depression and Incidence of Symptoms in VX Intoxication, correlation of
5. Man, VX-penetration rate in
6. Symptomatology in VX Intoxication

FOR OFFICIAL USE ONLY

REQUEST FOR/OR NOTIFICATION OF REGRADING ACTION

For use of this form, see AR 380-5; the proponent agency is DACSI.

DATE: 3 March 2003

FILE:

READ INSTRUCTIONS ON REVERSE SIDE BEFORE COMPLETING THIS FORM

TO: *(Include ZIP Code)*
Defense Technical Information Center (DTIC)
8725 John J. Kingman, Suite 0944
Fort Belvoir, VA 22060-6218

FROM: *(Include ZIP Code)*
Commander
U.S. Army Soldier and Biological Chemical Command
ATTN: AMSSB-ISI-E
Aberdeen Proving Ground, MD 21010-5424

☒ THE DOCUMENT(S) DESCRIBED BELOW HAS/HAVE BEEN REVIEWED FOR REGRADING AND ACTION HAS BEEN TAKEN AS INDICATED. APPROPRIATE ACTION SHOULD BE TAKEN TO MARK YOUR COPIES AND NOTIFY ALL RECIPIENTS TO WHOM ADDITIONAL DISTRIBUTION WAS FURNISHED IN ACCORDANCE WITH AR 380-5. DOCUMENTS CONCERNING THIS SAME SUBJECT SHOULD BE REVIEWED FOR POSSIBLE REGRADING.

☐ REQUEST DOCUMENT(S) DESCRIBED BELOW BE REVIEWED TO DETERMINE WHETHER THEY CAN BE DOWNGRADED OR DECLASSIFIED AT THIS TIME. *(Include justification in the "REMARKS" section of this form.)*

☐ REQUEST APPROPRIATE CLASSIFICATION/REGRADING INSTRUCTIONS FOR DOCUMENTS DESCRIBED BELOW.

CONTROL NUMBER	DESCRIPTION *(TYPE, FILE REFERENCE, UNCLASSIFIED SUBJECT OR SHORT TITLE, INDORSEMENTS, INCLOSURES)*	CLASSIFICATION/ REGRADING INSTRUCTIONS	
		OLD	NEW
AD003601	MLRR-147 THE PROTECTIVE ACTION OF STANDARD CLOTHING MATERIALS AGAINST PERCUTANEOUS EXPOSURE OF MONKEYS TO GB VAPOR (U) OBERST, F.W., ET AL[This report was regraded Unclassified by authority of Chief, Tox Div, 26 Jan 59,Cornelia L.Murphy, Classified Documents Review Committe, CW Labs, A Cml C, MD	SECRET	U (CUI) *SEE NOTE
AD 029550	MLRR 250, THE TOXICITY OF LIQUID GA APPLIED TO THE SKIN OF MAN (U), FREEMAN, ET AL [This report was regraded Unclassified by authority of Direcrorate of Medical Research ,19 Feb 59 by Cornelia L. Murphy, Chief, Document Review Section, Security Office, C W Labs, A Cml C, MD	SECRET	U (CUI) *SEE NOTE
AD026579	MLRR 217, THE TOXICITY OF LIQUID GB APPLIED TO SKIN OF MAN (U), FREEMAN, ET AL [This report was regraded Unclassified by authority of Directorate of Medical Research, CWL, 19 FEB 59, by Cornelia L. Murphy, Chief, Document Review Section, Security Office C W Labs, A Cml C, MD	SECRET	U (CUI) *SEE NOTE
AD 014540	THE ESTIMATION OF THE TOXICITY OF GB TO MAN (U), SILVER, S.D., report dated June 1953 [This report was regraded Unclassified by authority of review on 12 Feb 03 by International Programs Ofc Dr. Famini, Security Ofc (EAST), (Melody Turner-Goodall) Dr. Brennie Hackley and Dr. Sharon Reutter . Subject document is approx. 50 years from the date of its creation, and is therefore no longer determined to be classified.]	CONF	U (CUI) *SEE NOTE
AD 271163	CRDLR 3122, VARIABILITY OF DIFFERENT INTACT HUMAN-SKIN SITES TO THE PENETRATION OF VX, FEB 1962, DR. VAN M. SIM	FOUO	CUI *SEE NOTE

PRINTED OR TYPED NAME AND TITLE OF OFFICER	SIGNATURE
MELODY TURNER-GOODALL CHIEF, EDGEWOOD AREA SECURITY TEAM AMSSB-ISI-E, ABERDEEN PROVING GROUND, MD 21010	Elaine Galchab

DA FORM 1575, SEP 77 EDITION OF 1 SEP 62 IS OBSOLETE. USAPPC V3.00

REMARKS

Documents declassified to Controlled Unclassified Information (CUI). References and bibliographies were removed from the documents. Information is subject to Export Control lLaws. These documents contain technical data whose export is restricted by tthe Arms Export Control Act (Title 22 U.S.Code Sec 2751, et. seq) or EO 12470. Violators of these export laws are subject to severe criminal penalties.
These douments HAVE NOT BEEN cleared for public release
DISTRIBUTION is limited to U.S. Government Agencies and U.S. Government Contractors
EXCEPTION:
DISTRIBUTION is authorized to NATO countries only (NOT to Partners for Peace)
Any data that contains information from the these reports would need o be safeguarded as NATO Restricted.

ACTION TAKEN OR RECOMMENDED BY RECIPIENT

INSTRUCTIONS

1. Prepare sufficient number of copies to furnish one copy to each addressee of the original document and one copy for retention. Entries on form may be printed in ink.

2. Care will be taken to completely identify the document(s) being regraded to prevent error by the recipient. All inclosures being regraded will be accounted for. When covering document only is being regraded and there are inclosures *(classified or unclassified)* which are not being regraded, the symbol "n/c" will be entered in the OLD/NEW columns. The regrading form will contain unclassified information only. Short titles will consist of the first letter of each word in the subject or title except when a formal short title has been assigned.

3. The abbreviations authorized by DoD 5200.1-R and AR 380-5 will be used to indicate the old and new classifications and regrading instructions. Include declassification dates.

4. When the document(s) will be regraded upon the occurrence of an event, the classification will be followed by an asterisk (*) and the event described at the bottom of the form or in the "REMARKS" section, above.

5. When the form is used as a request for review, the need for a lower classification for the document or documents will be shown.

DEPARTMENT OF THE ARMY
US ARMY RESEARCH, DEVELOPMENT AND ENGINEERING COMMAND
EDGEWOOD CHEMICAL BIOLOGICAL CENTER
5183 BLACKHAWK ROAD
ABERDEEN PROVING GROUND, MD 21010-5424

REPLY TO
ATTENTION OF

JAN 06 2017

RDCB-DSR-S

MEMORANDUM THRU Director, Edgewood Chemical Biological Center, (RDCB-D/Dr. Joseph L. Corriveau), 5183 Blackhawk Road, Aberdeen Proving Ground, Maryland 21010-5424

FOR Defense Technical Information Center (DTIC), 8725 John J. Kingman Road, Ft Belvoir, VA 22060-6218

SUBJECT: Request for Change in Distribution

1. This action is in response to an Edgewood Chemical Biological Center (ECBC) Internal Request for a Change in Distribution for the attached listed documents:

2. The listed documents have current distribution statements or classifications which limit their release. ECBC Subject Matter Experts have reviewed the documents and deemed them suitable for the change in distribution to read "Approved for public release; distribution unlimited."

3. The point of contact is Adana Eilo, ECBC Security Specialist, (410) 436-2063 or adana.l.eilo.civ@mail.mil.

Encl

RONALD L. STAFFORD
Security Manager

ECBC Documents for Downgrading/Change in Distribution

1. Callahan, J.F. *The Relation between Skin Thickness and the Penetration Rate of VX through Skin.* In *Research Program of the Field Toxicology Branch;* CRDL TM 20-27; Callahan, JF, *et al.* Eds.; Directorate of Medical Research, U.S. Army Chemical Research and Development Laboratories, U.S. Army Chemical Center: Edgewood Arsenal, MD, 1962; UNCLASSIFIED Report. **CBRNIAC-CB-118810 Dist. E.**
Recommended for public release.

2. Callahan, J.F.; Cresthull, P.; Christensen, M.K.; Crook, J.W.; Wiles J.S.; Owens, E.; Hart, J.; Worden, F.X. *Intravenous Toxicity of VX* in Marzulli *et al. Biological Studies on VX during Fiscal Year 1958*; CWL Special Publication 2-18; U.S. Army Chemical Warfare Laboratories: U.S. Army Chemical Center, 1959; UNCLASSIFIED Report **AD0313760 Dist. C.**
Recommended for public release.

3. Frankel, H.M.; Wiles, J.S. *Lethality of VX in Rats at High and Low Temperatures;* CRDLR-3023; U.S. Army Chemical Research, and Development Laboratories: Edgewood Arsenal, MD, 1960; UNCLASSIFIED Report **AD0243462 Dist C.**
Recommended for public release.

4. Marzulli, F.N. *A Comparison of Toxic Properties of the V Agents with GB*; MLSR-75; U.S. Army Chemical Corp Medical Laboratories: U.S. Army Chemical Center, MD, 1955; UNCLASSIFIED Report **AD0090916 Dist. C.**
Recommended for public release.

5. Reutter-Christy, S.A.; Sommerville, D.R.; Edward M. Jakubowski; Christopher E. Whalley; Bernard J. Benton; Stanley W. Hulet; Paul A. Dabisch; Ronald A. Evans; Jeffrey M. McGuire; Charles L. Crouse; R Christopher E. Byers; James H. Manthei; Ruth W. Moretz; Jeffry S. Forster; Bernardita I. Gaviola; David C. Burnett; William T. Muse; Kathy L. Matson; Robert J. Mioduszewski; Sandra A. Thomson; Julie A. Renner; Allison L. Totura; Edward J. Emm; Stephen R. Channel; Tsung-Ming Shih; Lucille A. Lumley; John O'Donnell; Theresa Ward; Bountieng Somsamayvong; Christopher Robison; Susan Schulz; Kelly L. Ault; Edward D. Clarkson; Raymond F. Genovese; John L. Oubre; Patrick J. Fleming. *Chemical Warfare Agent Operational Exposure Hazard Assessment Research: FY07 Report and Analysis*; ECBC-TR-784; U.S. Army Edgewood Chemical Biological Center: Aberdeen Proving Ground, MD, 2010a.
ADB370363 Dist. C. Recommended for public release.

6. Reutter, Sharon A.; Moretz, Ruth W.; Murray, Michele M.; Sommerville, Douglas R., *Review of Toxicological Data Regarding Contact Hazards of Chemical Agents*, ECBC-TR-514; U.S. Army Edgewood Chemical Biological Center: Aberdeen Proving Ground, MD, 2006; UNCLASSIFIED Report **ADB321921 Dist. C. Recommended for public release.**

7. Sim, V.M. *Variability of Different Intact Human-Skin Sites to the Penetration of VX*; CRDLR-3122; Chemical Research and Development Laboratories: Edgewood Arsenal, MD, 1962
AD0271163 Dist. C. Export Control Recommended for public release.

8. Sim, V.M; Stubbs, J.E. *VX Percutaneous Studies in Man*; CRDLR-3015; Chemical Research and Development Laboratories: Aberdeen Proving Ground, MD, 1960
AD0318533 Dist. F. Recommended for public release.